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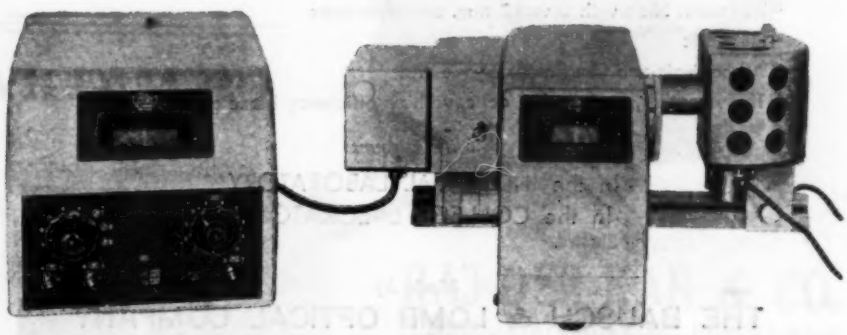

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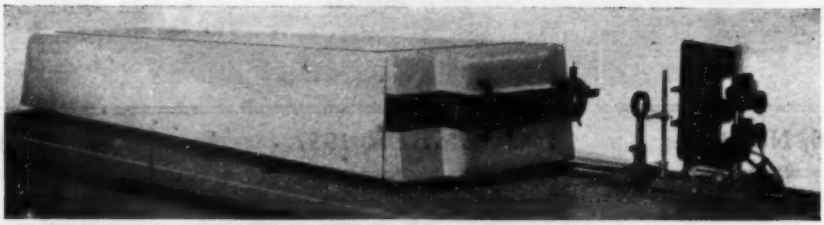

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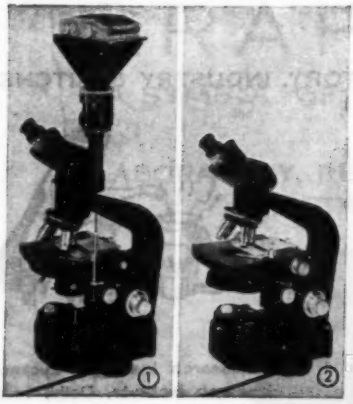

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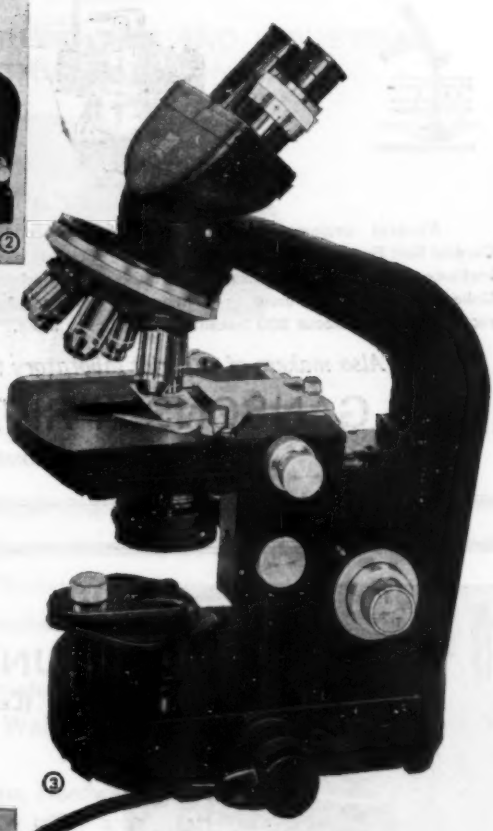

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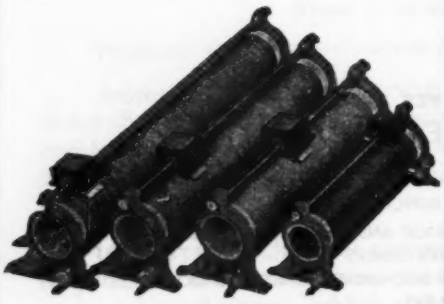

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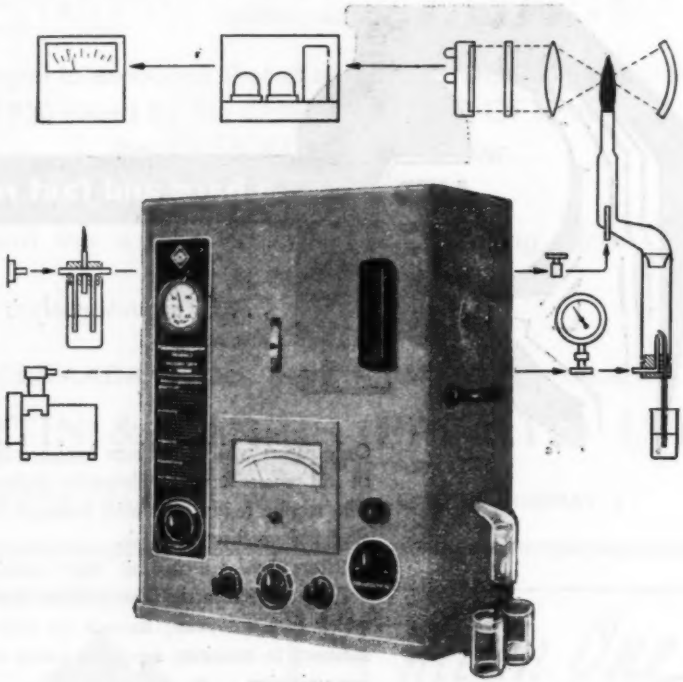

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THE EARTH'S MAGNETIC FIELD

THAT the earth has an associated magnetic field has been known for many centuries, and its effect on a small freely suspended magnet has long been used as a navigational aid. Such an arrangement can equally well be used for discovering the properties of the earth's magnetic field, in particular its form over the surface of the earth or—by a sufficient refinement of the apparatus—any fine details or small changes that may be found at a chosen locality. During the first half of the nineteenth century, the German mathematician Gauss found it possible to separate the total magnetic field measured at the earth's surface into two distinct components, one of internal and the other of external origin. The field due to internal origin is by far the larger component of the two. It has a similar form to, though not identical with that produced by a bar magnet with its axis inclined at a small angle of about 11° to the axis of rotation of the earth.

The field to be measured is never large; the maximum strength is about 0·7 gauss and often, the details of interest are one-thousandth of this value. The external field is transient in character and exhibits a most complex structure depending upon the relative configuration of Earth, Sun, and Moon, the season of the year, and on the physical state of the Sun, in contrast to the main field which is independent of all these variables. The source of the transient field has been traced to the atmosphere.

The main field has a number of components of which that corresponding to a dipole field is the most prominent. The best fit dipole field has an equatorial horizontal component of 0·312 gauss and a magnetic moment of $7{\cdot}06 \times 10^{25}$ c.g.s. units. There is some empirical evidence to suggest a decrease of magnetic moment, by a few per cent. during the last century.

The deviations of all the elements from the corresponding dipole form are time-dependent, a fact discovered empirically and expressed in terms of a secular variation. The average annual change at each location is about 50γ ($\gamma = 10^{-5}$ gauss).

The data on the past field are also of great interest, and recently these have begun to be inferred from a study of the remnant magnetism of certain natural rock formations, either sedimentary or igneous, containing small grains of ferromagnetic impurity such as Hermitite or Magnetite. Before a rock is formed, the impurity grains behave as small suspended magnets and get oriented in sympathy with the local field. On subsequent compression or cooling, the particle orientation is preserved, thus, leaving a magnetic record of known geological age. Data are now available covering the range 800 million years ago to historical times, and a smooth link with the modern results has been obtained by the study of artificial architectural structures, and of volcanic lava of accurately known age. From a study of the values of dip certain important conclusions have been drawn. It is found that the dipolar axis has changed gradually with time. The evidence is in favour of considerable wandering: for example, some 800 million years ago the North magnetic pole would have been in Central North America: from here it moved south-westward across Pacific Ocean to near the Marshall Islands, then towards Japan and finally across Siberia to its present position (76° N., 102° W.). Measurements made both in Europe and North America lead to paths of the same form, and this result is interpreted as due to continental drift. The present obliquity angle between the geographical and magnetic pole though small is likely to represent a maximum value, and in the past seems to have been rather smaller. Although the orientation of the earth's axis of rotation is fixed in the main relative to the plane of the ecliptic, the rotation axis appears to have kept company with a wandering magnetic axis; the total evidence is intelligible only if the terrestrial surface features have moved relative to the solid mass of the earth which has remained unaffected in space. A slow relative slip between the mantle and core is, therefore, a reasonable conclusion on dynamical and mechanical grounds. Implicit in it is the assertion that the source of the magnetic field is to be found in the core.

When we consider the dip direction, another surprising result emerges out namely, the polarity reversal. Observational data imply that the polarity of the total dipole field has in the remote past reversed not once, but many times with time reversals of the order of 10^6 years.

Recent astrophysical work has shown conclusively the general occurrence and fundamental importance of magnetic fields in the Universe and these fields often show polarity reversals. It is well established that the Sun possesses a general stable small dipole field in addition to local fields of the magnitude 10^3 gauss, connected with sun spots. Polarity reversal has been observed not only in the Sun but also in some magnetic stars, characterised by an associated strong variable, non-sinusoidal magnetic field of the order of 10^3 gauss.

It is well known that the magnetic field in a conductor decays exponentially, depending on the electrical conductivity and linear dimensions of the conductor. If the conducting sphere has the same size as the earth, the decay time is of the order of few times $\times 10^4$ years; and if the sphere has stellar size, the decay time is increased to 10^{10} years. Therefore, it can be said with confidence that for objects of astronomical size the decay time is appreciably greater than the present accepted age of the Universe (5×10^9 years), the cosmic magnetic fields being essentially permanent features and the electrical conductivity effectively infinite.

The following conclusions are to be drawn at the present time concerning the occurrence of magnetic fields:

(*i*) Electrically conducting matter in motion has associated magnetic fields; so that the problem of production and amplification of such fields is very likely to involve also considerations of the dynamics of matter; (*ii*) The problem of maintaining an already established field arises only in condensed bodies of planetary size; (*iii*) Because the earth is the only planetary body known to have a magnetic field, its study must proceed independently; and (*iv*) Nevertheless, polarity reversal is found generally and the earth's field might ultimately be found to form one special manifestation of a more general cosmic feature.

Theories of origin of the main terrestrial field based upon the presence of magnetised materials either in the main body of the earth or the crust does not seem to be valid, for, the temperature inside is much above the Curie point and the crustal specific magnetisation is much larger than the measured values respectively. An alternative approach is the possible inadequacies of Maxwell's equations for regions of large volumes and for such systems, conventional equations must be augmented by terms which associate the magnetic moment

with material angular rotation. Laboratory investigations by Blackett and others have unanimously decided that the magnetic rotation effects are absent.

The other conventional source of the magnetic field is an electric current system within the earth. This approach is concerned with the details of the possible production and location of such a current system, along with the investigation of its properties and those of the associated magnetic field. The electrical conductivity must be a controlling factor, since internal energy sources for electromotive forces are limited. For this reason, the core is electrically the region most likely to act as a source for the observed magnetic field and the importance of this in this connection was inferred before, on the basis of pole wander. Further, the essential importance of fluid flow for the problem of the magnetic field follows immediately from the failure of the mechanisms depending on the solid phase. The assertion that the origin of the field at the surface is traceable to the intricate three-dimensional fluid core notions has no significant competitors. The fact that part, if not all the core is liquid must add physical weight to the argument.

The theory of the earth's field is then reduced to a study of the mutual interaction between an electrically conducting fluid and a permeating magnetic field. The movement of a conducting fluid across a magnetic field is known to induce an electromotive force in the fluid which gives rise to electric currents; these interact with the permeating initial magnetic field, providing what amounts to an electromagnetic body force to act on the fluid, in addition to the purely hydrodynamic body forces that are independently present. The complex of phenomena can be analysed with a new branch of physics known as magneto-hydrodynamics. The introduction of the ideas of magneto-hydrodynamics at once envisages new effects, the significant one being the ability of an electrically conducting fluid immersed in a magnetic field to withstand shear in a more permanent manner than when the field is not present. For this reason the fluid is able to transmit transverse waves in addition to the longitudinal waves, normally to be expected and these are known as hydrodynamic waves. Seismic data clearly support these ideas and the inner core was recognised by its ability to carry transverse waves. On this assumption the theory leads to an inner core magnetic field of 10^5 gauss as an order of magnitude. The absence of transverse waves in the outer core is, on the new interpretation taken as evidence for the smallness of any field there. The severe restriction of the strong field to inner core region implies the presence of special fluid flow patterns in the outer core, derivable on the basis of hydromagnetic arguments and the dipole fluid observed at the earth's surface is to be regarded as a secondary effect. The fact that the surface field has a strength of only ½ gauss is not incompatible with the model: in the solar case the surface field is as small as 1 gauss although a strong internal field is present. It is to be concluded, therefore, that the empirical evidence supports the full appeal to magneto-hydrodynamics in treating the dynamic problem.

Field decay occurs through Joule heat losses which is an irreversible effect, and any augmentation of an existing field must involve the conversion of kinetic into magnetic energy according to the rules of magneto-hydrodynamics. Bullard in an important paper established, by reference to a special model, that a hydromagnetic dynamo mechanism is able to maintain a stationary field, once established. Independently, Elsasser has attempted to obtain solutions of the hydromagnetic equations which are directly applicable to the earth.

On purely qualitative grounds, however, the several terrestrial effects can be correlated. The core-mantle coupling which must be of viscous origin associated with the last stage of the decay of turbulent motion, will depend on the magnetic conditions in the core. If the secular variations be associated with fluid motion in the outer core and the westward drift of the surface field be ascribed to a differential rotation between the mantle and the core, then changes of the magnetic conditions in the core can be expected to affect the coupling; the observed correlation between anomalies of the secular change and terrestrial rotation becomes intelligible.

Polarity reversal remains unexplained and falls within the range of arguments concerned with the initial production of magnetic fields. That the turbulent motion is intimately connected with the production of magnetic fields is usually accepted to be true. The production of magnetic fields in Nature still remains an unsolved problem, and it has not yet been unambiguously demonstrated that turbulent motion can spontaneously give rise to a magnetic field and that such a field can be amplified. The origin of the earth's main field is still not understood but it is clear that the first steps of a theoretical treatment have been taken. It is virtually certain that the effect is

hydromagnetic and located in the core, and that the non-linear form of the theory is fundamental.

Further progress is expected to be made during the International Geophysical Year since the earth's magnetism is one of its highly interesting and important properties.—(*Based on an article by G. H. A. Cole, Science Progress, 1957, Vol. XLV, pp. 628-45.*)

THE NEW AUSTRALIAN RADIO TELESCOPE

A NEW radio telescope designed by Dr. Wilbur Christiansen of the Radio Physics Division of Australia's Commonwealth Scientific and Industrial Research Organisation, Sydney, has been completed and put into operation, in time for the opening of the International Geophysical Year which commenced in July 1, 1957. The task of building a high precision radio telescope with an extremely high angular resolution was undertaken by Dr. Christiansen in 1954, and the telescope is located near the small industrial town of St. Mary's on an abandoned airfield; about 30 miles from Sydney.

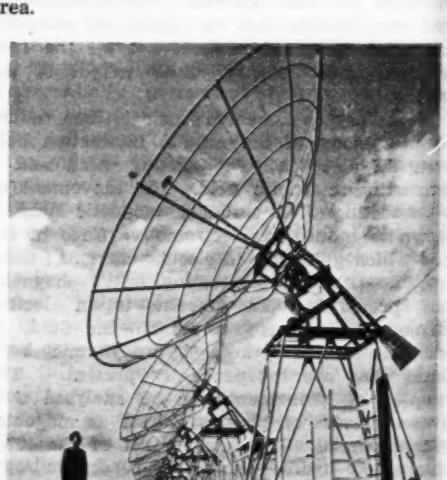
The new telescope is the outcome of a previous interferometer built and used by Christiansen, known as "Christiansen interferometer" which consisted of 32 parabolic dishes, each 6 ft. in diameter arranged in a line 700 ft. long. The dishes constituted a kind of coarse diffraction grating that gave a reception diagram formed by narrow and widely-spaced fringes. As the Sun crossed the field of the instrument each fringe scanned the disc, somewhat as the exit slit of a spectroheliograph, and localised sources of radio emission could be pin-pointed with considerable accuracy.

This instrument established in detail the origin of enhanced radio emission in active areas of the Sun marked by sunspots, bright hydrogen flocculi and other optical signs of disturbances in the solar atmosphere.

Minimum sunspot activity marked the period from 1951 to 1954, ideal for the multiple interferometer to function effectively. There was seldom more than one active region at a time on the Sun. Knowing the position of a sunspot it was certain that a recorded peak came from that point and so the radiophysicists were able to get the information they sought for.

But after 1954, a state of maximum sunspot activity commenced and this created a large number of simultaneous active regions on the Sun. The "knife-edged" beam performance of the interferometer, receiving signals from narrow strips of the Sun, was not suitable for the new conditions. A shortcoming of the instrument was the fact that each beam received the total emission from the south-north strip that it scanned. This did not matter when it was known, that only one active region lay in a strip, but it mattered very much when two or more regions were active in a strip.

In order to overcome the limitations of the above interferometer, Dr. Christiansen designed the present instrument which combines the principles of the former with the "Mills Cross" interferometer. The principle of Mills Cross is essentially the following. Two long intersecting aerial elements arranged in the form of a cross, produce a pair of intersecting beam and only the point of intersection is capable of receiving signal. By this arrangement, a high directivity for the aerial system is obtained though it is at the sacrifice of the collecting area.



Photograph of the Radio Telescope
By Courtesy of the Australian High Commission, New Delhi.

The new telescope consists of 64 paraboli dishes, each 19 ft. in diameter and erected o an equatorial mount. Each arm of the cro consists of 32 dishes, with 40 ft. space betwee

them and extend 1,240 ft. in length. The arms intersect at right angles in the centre. The telescope produces two series of knife-edged beams, which individually measure only one-thirtieth of a degree in width. One series intersects the other at right angles, forming an invisible celestial radio lattice. But the connecting lines of the lattice are cut out, leaving only the points of intersection. The instrument is so planned that only one point of intersection at a time can fall on the Sun and it can focus on an area of less than 1% of the whole. As soon as one point scans across the Sun, another starts, and so on, each moving a little higher than the one before.

The "Chris-cross" does not look at the photosphere—the sun's surface—but it is directed at the lower corona, close to where this joins the chromosphere. Optical telescopes can see the corona only outside the rim of the Sun, but the new telescope can see it right in front of the disc. The whole instrument moves automatically to allow for the earth's rotation and to keep focussed on the Sun on its journey across the sky.

The dishes are made from aluminium tubing and are lined with chicken wire having a metal pole projecting from the centre, to contain the aerial. Each pair of dishes has connecting wires underneath; each pair of pairs has connecting wires; and so on until the main wires from each arm meet at a central receiving point. Radio signals from the Sun are intercepted by the chicken wire and focussed on the aerials. The signal picked up by the aerials are fed into the system of cables, much as tributaries feed a river. Before moving into the receiver the energy from each arm is collected separately. To provide a modulated record, the polarity of the energy from the east-west arm is reversed many times a second before it is combined with the energy from the north-south arm. Finally the combined stream of energy passes on to the recording equipment, where it is mapped on paper.

The successful culmination of a scheme of such a gigantic nature represents the excellent co-operation of engineers, laboratory and workshop staff who partook in it.

The telescope is a big step forward, and can be used to pin-point the active areas on the Sun which seem to be responsible for radio outburst of large intensity. These active regions which occur around sunspots are one of the great mysteries of the Sun. They are the source of most radio waves coming from the Sun; they cause magnetic storms and radio fade-outs; they may even affect the weather. But the exact nature of these regions are at present only conjectural and this is one of the problems waiting to be solved.

It is just possible that this telescope will provide the answer by itself. But it is more likely that the answer will come by combining results obtained from radio-astronomical studies with optical work that are being carried out in Australia and in other parts of the world.

NEW ELECTRONIC DEVICES

TWO new electronic devices which may rival the vacuum tube and the transistor in electronic technology have been announced. They are the "solion", developed by the Naval Ordnance Laboratory in Washington, D.C. and the "spacistor", developed by a team of physicists of Raytheon Manufacturing Company of Waltham, Mass.

The "solion" depends on the movement of ions in a solution, instead of gas or a vacuum, as in the vacuum tube, or in a solid, as in the transistor. The ions flow between electrodes in an iodine solution. The device is highly sensitive to changes in outside conditions. The electric flow of ions, for example, can be stimulated and varied by changes in temperature, pressure, light, sound and acceleration. In certain applications, it promises to be more selective, sensitive, and efficient than the vacuum tube or the more recently developed transistor. It is expected to make possible less expensive, smaller and simpler electronic control systems.

The "spacistor" operates on what is described as "a wholly new principle". It is a semiconductor device, as tiny as the transistor, that operates electrically like a vacuum tube. It is said to "combine many of the best properties of the vacuum tube and the transistor" and thus to be "a major step forward in the art of amplifying electric energy". The spacistor promises two major advantages over today's best transistors: it will probably amplify as much as 50 times higher than transistors; also, because spacistors can be made from materials unsuited for transistors. They are expected to operate at temperatures more than double the temperatures at which today's germanium or silicon transistors can operate. (*Science*, 1957, 126, 392.)

NOBEL PRIZE FOR PHYSICS

THE Nobel Prize for Physics for the year 1957 will be jointly shared by the two Chinese physicists, Professor T. D. Lee of Columbia University and Professor C. N. Yang of the Institute for Advanced Study, Princeton University. The award has been made in recognition of their outstanding work on the laws of parity, especially of its violation in weak interactions.

Parity is a concept which has played a fundamental role in physics ever since the discovery and development of wave mechanics. In quantum mechanics, each state of a system is described by means of a wave function $\psi(x, y, z, s)$ which is a function of the position of the particle and the orientation of its spin. Parity is an operation which inverts the position of the particle about the origin. Thus under the operation of parity, the above wave function will change into $\psi(-x, -y, -z, s)$. *The law of parity* asserts that $\psi(-x, -y, -z, s)$ should be either equal to $+\psi(x, y, z, s)$ or $-\psi(x, y, z, s)$. In the former case, the system is said to be of *even* parity while in the latter case it has an *odd* parity. In both the cases, $\psi\psi^*$ which defines the probability of finding the particle at the position (x, y, z) and with its spin described by the co-ordinate s, remains the same. In a simpler language, the law may be stated by saying that Nature does not allow any distinction between left-handed and right-handed systems.

It was supposed till recently that parity should be conserved in every nuclear reaction. Conservation of parity means that the parity of an isolated system is a constant of motion and cannot be changed by internal processes. The law therefore prohibits the mixing of states of opposite parities. It is this belief that Lee and Yang challenged last year. From an analysis of the experimental data on the decay schemes of the θ^+ pue τ^+ mesons, they arrived at the conclusion that there is no experimental support for the law of conservation of parity for the case of weak interactions, *viz.*, decay interactions for the mesons and hyperons and various Fermi interactions. In addition, they suggested a number of experiments by which one may determine whether weak interactions differentiate the right from the left.

The suggestions of Lee and Yang were tested recently by C. S. Wu from the Columbia University, and E. Ambler and others of the National Bureau of Standards, U.S.A. Experimenting with a set of polarised nuclei of radioactive isotope Cobalt 60, they noticed a strong asymmetry in the angular distribution of the electrons emitted during β decay of the isotopes, along the direction of the nuclear spins and opposite to it. If the parity law were valid, one should expect an equal number of electrons along and opposite to this direction, but actually it was found that the intensity of the electrons along the direction of the nuclear spins was 40% larger than it was in the other. This establishes, beyond doubt, the violation of the law of parity in processes involving β-decay. Observations on the decay scheme of mesons also have likewise proved that the law of parity cannot be extrapolated for weak interactions.

The work of Lee and Yang and the experiments carried out at their suggestion have cast doubts on the correctness of a few other laws also, which were hitherto held to be valid, like the laws of invariance under charge conjugation and time reversal. The theory of electrons developed by Dirac in 1928 predicts that Natural laws are symmetrical between positive and negative electric charge; that is, to every particle, there exists another with the same mass and other physical characteristics, but with opposite charge or magnetic moment. This law, known as the principle of charge conjugation, was first successfully verified in 1930 when Anderson discovered the positron, and more rigidly confirmed by the production of 'antiprotons' and 'antineutrons' last year in the laboratory. Lee and Yang remark that neither the law of conservation of parity nor of invariance under charge conjugation is separately valid, but natural laws, nevertheless, are invariant under the combined operation of parity and charge conjugation. Thus anti-cobalt 60 would emit its positron in the opposite direction to cobalt 60, and neutrino—a massless, chargeless particle which has its spin parallel to its momentum representing a right-handed screw, finds its counterpart in the anti-neutrino whose spin is anti-parallel to its momentum representing a left-handed screw. By combining the two asymmetries, one can build up a higher symmetry, as it were, which has come to be known as the combined parity principle. If our universe is composed predominantly of particles of one kind of parity and charge, that is just a matter of accident only; far away at the distant galaxies, there might exist universes wherein the structural units are anti-particles that have opposite senses of screw to those of ours, and Nature as a whole preserves its symmetry in an overall majestic cosmological scale.

K. S. V.

POLYMERS AS STUDIED BY SOME PHYSICAL METHODS

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Introduction

THAT high polymers are composed of large structures built up by the successive repetition of small units was first pointed out by Staudinger[1] in 1920. This simple hypothesis has, during the last three decades, stimulated a large amount of both experimental and theoretical work. The high polymer molecule may thus be looked upon as just a long chain endowed with the ability to assume all sorts of configurations through rotations about its valence bonds. Under such circumstances, we have to speak of average size, average shape and so on.

In addition to developing theoretical concepts based on statistical methods of dealing with such problems, diverse experimental investigations such as determinations of turbidity, osmotic pressure, acoustic absorption and viscosity of these polymers in solution, have been undertaken with a view to estimate their effective sizes, shapes and molecular weights. In the glassy or solid state too, they exhibit other characteristic and easily measurable physical properties such as rubber elasticity and photoelasticity. Experimental techniques involving both static and dynamic methods, the frequencies used in the latter ranging from sonic to the ultrasonic, have been pressed into service in recent times to study such interesting mechanical properties.

Relaxation Effects in High Polymers

It follows that in such long chain polymer molecules, because they are flexible and can take up many different shapes, certain shapes are sometimes more probable than others and if a molecule is distorted from a more probable shape, it tends to return to it in a very short time when the distorting stress is removed. The rapidity with which the more probable shape is regained determines the relaxation time for such a configurational elasticity. The measurement of the propagation constants of acoustic waves is a well-known means for studying such mechanical relaxation effects.

The dispersion in solid samples of several polymers of ultrasonic velocity and of absorption of longitudinal and torsional waves was observed by earlier workers.[2-4] Work on concentrated polymer solutions in the audio-frequency range by Ferry and his co-workers,[5,6] has revealed that there is a dispersion of dynamic rigidity and the dynamic viscosity. These studies have established a strong correlation in the distribution of the relaxation times of such solutions with those of the corresponding solid polymers. Mason and co-workers[7] found from measurements with longitudinal ultrasonic waves, a dispersion of velocity and an associated dispersion of attenuation in polyisobutylene liquids. Direct measurements of shear viscosity and shear elasticity of these liquids by the torsional crystal method developed by Mason[8] showed that a relaxation occurs in the shear modulus and that the dispersion of the longitudinal velocity in these liquids is due to the dispersion of their shear elasticity.

The mechanical properties of solids, pure liquids and concentrated solutions of high polymers appear to be affected by interchain reactions arising from the close proximity of the polymer molecules to one another as well as by intrachain reactions pertaining to the chain of a given molecule itself. In studying the possible motions occurring within the chains, it is desirable to isolate the two effects. This is accomplished by taking such dilute solutions of the polymer that the molecules do not touch each other on the average (about 1 g./100 c.c.). In such solutions, the thermal motions of the segments in the polymer molecule co-ordinate with one another to produce changes in the configuration of the molecules and the configurational changes are associated with a series of relaxation times. Baker and his co-workers[9] employing the torsional crystal method showed the existence of three relaxation frequencies for dilute solutions of polyisobutylene in cyclohexane. Similar results were obtained by Rouse and Sittel[10] for polyisobutylene dissolved in different solvents like cyclohexane, benzene and toluene and for polystyrene dissolved in toluene. These relaxation frequencies characterising the configurational relaxation between different members of the chain, range from audiofrequency to the megacycle region.

With a view to study such relaxation effects in the megacycle region, measurements of velocity and absorption in dilute solutions of some vinyl polymers have been undertaken by the present writer and his co-workers and some very interesting results obtained. The method adopted is similar to that described by Pellam

and Galt.[11] A second crystal was used instead of a reflector and the ultrasonic velocity and absorption have been measured. The two crystals employed have identical fundamental frequencies, namely, 1·18 mc./s. and were worked at their 3rd, 5th and 7th harmonics. The temperature was controlled to within ± 0·5° C. The alignment of the crystals as well as the accuracy of the method as a whole was tested by making measurements on standard liquids like benzene and CCl_4, at all the frequencies. For absorption measurements, the height of the received pulse was adjusted to be constant by using a calibrated decade attenuator with a bandwidth of 0 to 30 mc./s. and capable of reading correct to 0·1 db. The absorption measurements are accurate to within 3 to 6%, the lower limit applying to higher frequencies.

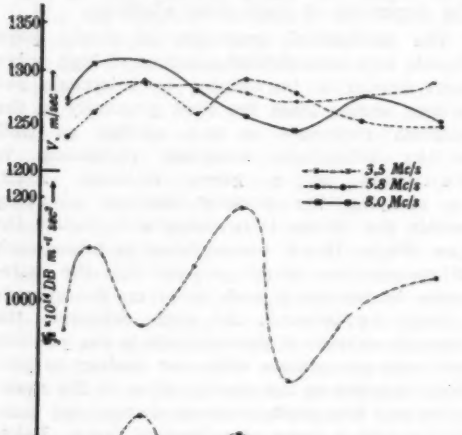

FIG. 1

Solutions in benzene of fractionated polymers exhibit a peculiar and hitherto undiscovered phenomenon consisting of rapid fluctuations both of velocity and of absorption from the values appropriate to pure benzene, as the concentration is varied. This new result, first observed in polyvinyl acetate is found to exist in the cases of polymethyl methacrylate and polystyrene also. Several fractions of the same polymer with different molecular weights ranging from 20,000 to 600,000 have been studied by way of confirmation.

The variation of velocity and of (α/f^2) where α is the absorption coefficient, with concentration is plotted for one fractionated polyvinyl acetate sample in Fig. 1. The "wobbling" of these factors with concentration is most striking and appears to result from the presence of a number of relaxation frequencies characteristic of the polymer molecule.

Fig. 2 shows the plot of $\alpha\lambda$ (absorption per wavelength) against the frequency, for one fraction of polyvinyl acetate as an illustration. Each curve in the graph represents the values for a particular concentration of the solution mentioned alongside the curve. In the range of frequencies studied, there is a frequency at which the maximum for $\alpha\lambda$ is occurring for

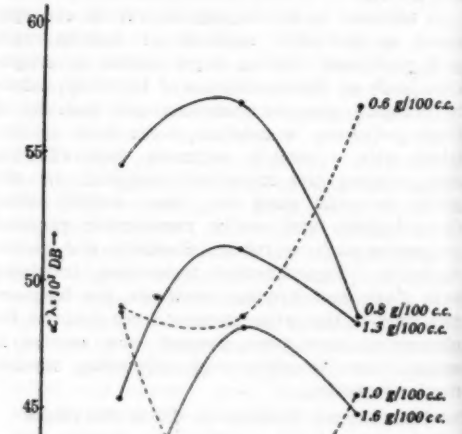

FIG. 2

some concentrations of the solution, while for some others a minimum absorption is observed. The frequency showing the maximum absorption is not the same for all concentrations and is found to vary in an irregular fashion. Further extensive results have been obtained which show that the velocity is not constant with frequency and also that its variation is erratic. The above results observed in the case of all the different polymer fractions, indicate the

presence of multiple relaxation frequencies. The minima observed for some concentrations in Fig. 2 can only be explained as due to the presence of at least two relaxation frequencies situated very close to each other and on either side of the minimum.

The above phenomena are however altogether absent when unfractionated commercial samples of polystyrene and polymethyl methacrylate are dissolved in benzene. That the peaks and depressions occur in such a closely spaced manner for the different fractions of the same polymer whereas they are not found at all before the fractions are separated can only be understood by presuming that they are apparently cancelled out by superposition in an unfractionated sample.

Moreover, it has been observed that unlike benzene which is a good solvent, in a poor solvent like ethyl methyl ketone, if measurements are made on a fraction of each of the above polymers, these phenomena are not exhibited. This has to be attributed to the lack of freedom to the polymer molecule in a poor solvent to assume different configurations as it is then known to be in a completely coiled state, all the relaxation effects being thereby suppressed.

Second Order Transitions in High Polymers

Another important feature of high polymers is that they generally exhibit a discontinuity in thermal expansion at a characteristic temperature. This temperature also marks a relatively abrupt change in other thermal, mechanical, electrical and optical properties. These discontinuities are termed as second order transitions because as the temperature is raised through this point, there appears to be a change of state without latent heat. In many of these substances, the sound velocity varies with frequency, showing characteristic relaxation frequencies. Thus a study of physical properties of high polymers as affected by temperature and frequency is of considerable importance.

The experiments of Protzman[12] were the first to disclose the existence of a discontinuity in the slope of the velocity-temperature curves for ultrasonic waves in polymer materials. Working on methyl methacrylate polymers by the optical diffraction method, he found a transition temperature which decreased linearly with frequency; in the range of 3 to 11 mc./s., covered by his experiments. As pointed out by him, the observed frequency dependence would have the opposite sign if a relaxation mechanism were responsible for the discontinuity. This created a difficulty. Later, Melchor and Petrauskas,[13] working on the same polymer, did not find an appreciable dependence of the transition temperature on frequency, in the range 0·5 to 10 mc./s. They also noted that the transition occurred near a temperature T_g, the glass transition temperature, which was obtained from the length-temperature measurements using the same specimen of material. We have also determined the transition temperatures in a few polymers over a wide frequency range in order to arrive at a possible mechanism responsible for them and two different experimental techniques were employed. We covered the frequency range of 0·1 to 6 mc./s.

The two experimental methods used are the ultrasonic pulse method involving the principle of total internal reflection and the composite oscillator method for working in the low frequency region. A brief description of the two methods has already been given in earlier publications.[14] The variation of ultrasonic velocities with temperature has been determined in the case of polymethyl methacrylate and polystyrene. The specimens used in both experiments have been taken from the same sheet of the materials. Using the pulse method, Krishnamurthi and Sivarama Sastry[15] determined the velocities at four different frequencies, namely, 1·15, 2·30, 3·45 and 5·75 mc./s. The transition temperatures observed in both the polymers were found to be the same at all the four frequencies. Their results show the transition temperatures at 61° C. for polystyrene. Subrahmanyam,[16] employing the composite oscillator method, determined the same for both the polymers round about 0·1 mc. The transition temperatures obtained by him agree with the above values.

Thus in the frequency region of 0·1 to 6 mc./s. covered by the two experiments, the discontinuities in the V-T curves are found to be independent of frequency, in both polystyrene and polymethyl methacrylate. The exact value for the transition temperature in polymethyl methacrylate is a little smaller than that observed by Melchor and Petrauskas but the effect of plasticizer content, molecular weight, etc., in polymers can account for the substantial differences in the transition temperatures, as observed by different workers.

Supporting evidence to the above observation has since come from other workers.[17] Recent work of Wada and Yamamoto[18] has in fact shown that the transition temperatures, determined in the case of eight polymers, are independent of frequency. Using the two experimental methods described above, they covered

the same frequency region. Another result of their observations is that these transition temperatures occur very near those for thermal expansion (T_g).

A different line of work on polymers is the measurement of birefringence produced in samples of polymethyl methacrylate and polystyrene when subjected to stress. A detailed description of the experimental set-up and the results obtained have been given by Bhagavantam and Krishnamurty.[19] Transition points have again been observed in the birefringence temperature graphs, and they occur at the same temperatures as were found in the ultrasonic experiments. This result is in conformity with similar observations made on the widths of nuclear magnetic resonance absorption lines[20] and the dielectric constants of polymethyl methacrylate and polystyrene respectively, where discontinuities in the above quantities were again observed near the glass-transition temperature.

Viscometric and Light Scattering Studies of High Polymers

Viscosity and light scattering methods are now widely used to determine the molecular weights and the root mean square end to end distances for different high polymer molecules. The intermolecular interactions of such a polymer dissolved in a solvent can be characterised by a few thermodynamic parameters, and their evaluation for various solvent systems becomes important. For instance, the single polymer molecule dissolved in a solvent is subject to the osmotic action of the surrounding molecules which tends to swell it to a larger average size than it would otherwise assume, and can be represented by an average expansion factor of the unperturbed mean square end to end distance of the molecule. From measurements on the variation of intrinsic viscosity with temperature, it is possible to evaluate these parameters for the particular polymer-solvent system as well as the unperturbed dimensions of the molecule.

Light scattering photoelectric photometers have been built in various laboratories. They are usually calibrated by a narrow fraction of polystyrene or other standard polymers for which the molecular weight is arrived at independently, say by the viscosity method. The description of one such arrangement has been given by Varadaiah[21] in a paper which has been published recently in the *Journal of Polymer Science*. Molecular weights are obtained from light scattering data employing Debye equation.[22]

$$\frac{Hc}{\tau} = \frac{1}{M} + \frac{2Bc}{RT}$$

where $H = 32\pi^3 n_0^2 (n_0 - n_e)^2 / 3C^2 N\lambda^4$, and other letters have the usual significance. τ stands for the turbidity of the polymer solution for incident polarised light. $(n_e - n_0)/c$ or dn/dc is determined with a differential refractometer for different polymer solvent systems. The molecular weights are obtained from the Hc/τ *vs.* c graphs. By finding the asymmetry of scattered light at 45° and 135°, appropriate corrections are applied to molecular weights and the length of the polymer molecule is calculated, assuming a tangled coil model, by the usual procedure as explained by Oster.[23]

Conclusion

Many other tools of the physicist, such as the infra-red spectrometer, the X-ray diffraction camera and so on are finding their applications in the solution of intricate problems in polymer chemistry but, for want of space, these have not been dealt with in the foregoing. There is, however, no doubt that this is a field where much remains to be done by the experimenter as well as the theorist.

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INTERNATIONAL SYMPOSIUM ON BOUNDARY LAYER RESEARCH

AN International Symposium on boundary layer research, sponsored by the International Union for Theoretical and Applied Mechanics, was held from August 26 to 29, 1957, under the Presidentship of Prof. H. Görtler at the Institute of Mathematics in the University of Frieburg, Germany. It was a fitting tribute to the memory of Prandtl's pioneering work on boundary layer. One hundred delegates from seventeen countries registered for the Symposium. They included Th. Von Kármán, F. K. G. Odqvist, H. L. Dryden, G. I. Taylor, G. Temple, A. A. Townsend, J. Kampe de Feriet, R. Timman, B. R. Seth, I. Tani, M. Lunc, H. Faxen, J. Ackeret, C. C. Lin, ch. A. Rachmatulin, G. N. Patterson and O. Wehrmann. Thirty invited papers were read and discussed in four days. Films were shown depicting the behaviour of the thermal boundary layer, formation of horse-shoe vortices in boundary layer motion and in the wake behind three-dimensional obstacles. All the invited papers together with the discussions will be published by Springer-Verlag in Berlin.

On August 26, the first sitting began with welcome speeches by Prof. Görtler, Prof. Tellenbach, Rector of the University of Frieburg, and Dr. H. L. Dryden, Vice-President of the International Union for Theoretical and Applied Mechanics.

The papers that were read dealt with the mechanism of turbulent boundary layer flow. A. A. Townsend gave results of two experimental studies on the structure and motion of the large-scale eddy motion in the outer part of the turbulent boundary layer and the flow in the immediate neighbourhood of the free edge of a flat plate of finite aspect ratio. It was found that, while certain properties of the flow in the constant stress region might be uniquely determined by the wall stress and the fluid viscosity, others depended on the whole flow, and varied from one wall to another.

For a flat plate with fully developed turbulent flow at effective Reynolds number over one million, well developed eddies were found with their axes parallel to the edge and one on each side of the plate.

O. Bjørgum gave a mathematical theory of shear flow turbulence based on the following assumptions :

(i) Navier-Stokes' equations are valid ;

(ii) Steady-state turbulent flows exist.

His method and conclusions had some defects which were pointed out by Kampe de Feriet and C. C. Lin.

The second sitting was devoted to the exact and approximate calculations of boundary layer flows. J. Ackeret spoke on boundary layer effects in straight and curved diffusors.

B. R. Seth showed how the synthetic method could be used to get generalised forms of the boundary layer thickness and the drag coefficient. In this method the field equations are exactly solved by introducing a constraining force depending on a parameter n. As n becomes large, this force tends to vanish throughout the field if the Reynolds' number, R, is proportional to $n^{2+\lambda}(\lambda > 0)$. The boundary conditions are all satisfied and by taking the cases of a flat plate, a circular cylinder and a sphere, it is shown that the generalized forms of the boundary layer thcikness and the drag coefficient are proportional to $R^{-k/2+\lambda}$ and $R^{-k(1+\lambda)/(2+\lambda)}$ respectively, where $0 < k < 1$.

K. Stewartson showed that Howarth's conjecture that in the case of a rotating sphere, the two boundary layers occurring at the poles, collide at equator, was true. If the sphere was at rest and the liquid rotated, the boundary layer started at the equator and converged on the poles. In the case of a semi-infinite circular cylinder with a hemispherical boss, the boundary layers reaching the equator continued along the cylindrical portions and three regions could be distinguished.

M. B. Glauert showed that his results for the incompressible wall jet could be used for the compressible case if the coefficient of viscosity was proportional to the temperature. For unit Prandtl number a number of simple solutions could be obtained. Some departures from his similarity solution were also given.

The third sitting on August 27 was devoted to a discussion of stability of laminar boundary layers and transition to turbulent flow. G. B. Schubauer presented some experimental work being carried on at the National Bureau of Standards, Washington. By employing the vibrating ribbon technique to obtain waves of controlled frequency and intensity, he concluded that the origin of turbulence lay in the existence of some 'turbulent spots'. Then came the joint paper by H. Görtler and H. Witting on the theory of secondary instability of laminar boundary layers. A. Zaat discussed some numerical methods for stability problems.

C. C. Lin considered the effect of Reynolds' stresses on the growth of small disturbances

and found that it is often possible to produce a finite disturbance of definite amplitude resulting in distorted mean flow. These considerations are useful in determining the instability of laminar boundary layers, especially in high speed flow. The joint paper of E. A. Eichelbrenner and R. Michel on the phenomena of transition in three dimensions was the next to be presented in the fourth sitting. H. Bergh gave a method for visualizing periodic boundary layer phenomena. This method could be useful for determining more detailed experimental information about periodic boundary layers.

In the fifth sitting S. Ostrach, H. Schuh, S. A. Schaaf and L. Talbot, and M. Lunc presented their papers on thermal boundary layers and boundary layers in a rarefied gas. Ostrach studied the problem of forced and natural-convection fully developed laminar flow between two parallel planes oriented in the direction of the body force. The problem has its applications in the fields of jet propulsion, nuclear power and hypersonic flight.

The sixth sitting was occupied by papers on the interaction between shock waves and boundary layers. G. E. Gadd surveyed the occurrence and nature of the interaction. H. Mirrels described the wall boundary layer behind a moving shock wave.

The concluding day was devoted to unsteady and three-dimensional boundary layers. The seventh sitting opened with a paper by F. K. Moore on the separation of unsteady boundary layer. The problem could be split into two parts:

(i) A boundary layer which has a fixed separation point in the *quasi*-steady approximation; and

(ii) A steady boundary layer over a moving wall.

The separation point has been defined where velocity and shear vanish simultaneously. Obviously, if the wall is moving, this point cannot be at the wall. The paper was followed by L. N. Persen on the applications of integral transforms to non-stationary boundary layers. W. Wuest presented his paper on periodic boundary layers.

The contributors for the last session were R. Timman, K. Oswatitsch, I. Tani, and O. Wehrmann and R. Wille. The subjects included three-dimensional boundary layers, and experimental investigation of flow separation over a step.

B. R. SETH.

NOBEL PRIZE FOR CHEMISTRY

THE Nobel Prize for Chemistry has been awarded to Sir Alexander Todd, F.R.S., Professor of Organic Chemistry, University of Cambridge, for his contributions to the chemistry of nucleotides. The term nucleotide was originally confined to the phosphates of the N-glycosides of certain purines and pyrimidines known as nucleosides which are obtained by hydrolytic breakdown of the nucleic acids. Its scope has now widened and includes not only the phosphates but also the polyphosphates of N-glycosides of a variety of heterocyclic bases and it embraces also the nucleic acids or polynucleotides. Phosphorylated derivatives of riboflavin though fall outside the scope of the above definition are commonly included because of their close relationship to the main body of natural nucleotides. Professor Todd and his colleagues have been engaged in chemical investigations of nucleotides for the past fifteen years and have made outstanding contributions to the elucidation of the structure and synthesis of these biologically very important chemical substances.

Employing methods of organic chemistry mainly along two lines, one concerned with the structure of nucleic acids and the other with the complex nucleotide derivatives which exercise coenzyme function in many biological systems, they have developed new methods of synthesis which would be flexible in operation and mild enough, not to damage sensitive molecules such as those of the nucleotides.

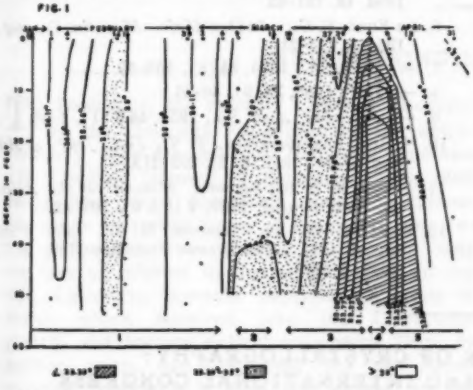
In the Bakerian Lecture to the Royal Society delivered on 17th June 1954, Prof. Todd under the title, "The Chemistry of the Nucleotides" presents a survey of the subject. Professor Todd has a multitude of other honours to his credit and the award of the Nobel Prize comes fittingly, in recognition of his monumental work in the above field of organic chemistry.

ON UPWELLING AND PRODUCTIVITY OF THE WATERS OFF LAWSON'S BAY, WALTAIR

P. N. GANAPATI AND D. V. SUBBA RAO

Dept. of Zoology, Andhra University, Waltair

LA FOND[6] (1954) based on examination of isotherms in temperature sections in the central part of the East Coast of India concluded that upwelling of subsurface layers of the sea occurs from March to May. With a view to find out whether this upwelling takes place in the inshore waters and if so, how far it influences the productivity of plankton, a series of Bathythermograph readings were made during the period January to April 1956 at a fixed station in the 10 fathom line in Lawson's Bay. The results are presented below and represented in Fig. 1. The changes in the chemical



constituents and the pigment units/M³ of Sea-water (Harvey's[5] method, 1934), together with the plankton volume/M³ of sea-water of the surface waters are given in Table I. The observations can be conveniently divided into 5 periods.

1. *January 28th to 6th March.*—During this period, the surface temperature ranged from 24·50° C. to 27·26° C. The temperature curves are nearly isothermal from surface to bottom. The temperature fluctuations from surface to bottom ranged between 1·7° C. and 0·04° C. The temperature gradients remain very weak until the first week of March. There is little heating from the atmosphere and little advection of water horizontally or vertically.

2. *March 9th to 16th March.*—The surface temperature during this period ranged between 24·88° C. and 25·27° C. The difference in the temperature between the surface and bottom waters ranged between 0·91° C. and 0·94° C. During this period the first definite indication of upwelling is seen by the influx of small quantities of colder waters at the bottom which is not, however, appreciable enough to influence the surface waters.

3. *March 19th to 1st April.*—During this period the surface temperature ranged between 24·05° C. and 25·22° C. The difference in temperature between the surface and the bottom waters ranged from 0·28° C. to 0·50° C. The slight rise in temperature on 19th March is followed by a rapid decrease in temperature starting at the bottom and rapidly extending to the surface.

4. *April 4th to 8th April.*—The surface temperature during this period ranged from 23·33° C. to 24·36° C. The range of tem-

TABLE I

Date	Salinity ‰	O_2 ml./l	PO_4 mg. at/L	SiO_3 mg. at/L	Plant pigments/M³	Pl. Vol. c.c./M
28-1-1956 ..	33·24	4·34	0·47	8·125	3000·0	162·50
1-2-1956 ..	33·24	3·82	0·48	11·250	2500·0	156·25
4-2-1956 ..	33·08	3·02	0·41	11·780	2400·0	46·80
14-2-1956 ..	32·10	3·42	0·44	13·500	437·5	31·25
16-2-1956 ..	..	..	..	..	750·0	31·25
28-2-1956 ..	34·04	4·18	0·32	10·625	1950·0	50·00
2-3-1956 ..	..	..	..	..	2080·0	75·00
6-3-1956 ..	34·43	4·98	0·42	8·200	6760·0	162·50
9-3-1956 ..	34·61	5·67	0·48	10·000	16447·5	300·00
16-3-1956 ..	34·31	4·67	0·72	7·500	18550·0	100·00
19-3-1956 ..	34·20	4·98	0·63	8·750	1125·0	125·00
27-3-1956 ..	34·38	4·98	1·60	12·500	7875·0	40·00
29-3-1956 ..	34·29	4·93	0·76	7·810	8125·0	40·00
4-4-1956 ..	34·88	4·64	0·87	9·225	13250·0	100·00
8-4-1956 ..	34·58	4·48	0·47	10·930	16875·0	225·00
12-4-1956 ..	34·40	..	0·48	10·625	862·5	20·00

perature from surface to bottom was 1·95° C. to 2·75° C. It is evident that the cold surface waters could only have their origin from the subsurface layers as there was no lowering of atmospheric temperature during the period. Again one would expect during this period warmer waters at the surface brought by the prevailing northerly current from the equatorial region. However both the prevailing atmosphere temperature and the wamer waters of equatorial origin are more than countered by the upwelling of subsurface cold waters.

5. *April 12th to 21st April.*—The range of surface temperature is from 24·05° C. to 25·22° C. The difference in temperature between the surface and bottom waters ranged between 1·11° C. and 0·52° C. During this period the waters are becoming warmer and the effect of upwelling is slowly diminishing.

From a close study of the physico-chemical conditions as shown in the table, it can be observed that during periods of upwelling, namely, the periods 2 and 4, the waters are characterized by the increase in salinity, phosphates and silicates and rich phytoplankton content. The plant pigment values were at their maximum during the above periods. The nutrient rich bottom waters come up to the surface and thus enrich the waters which support a rich phytoplankton crop. Our results are in agreement with the previous works[1–4,6,10] carried out in other parts of the Bay of Bengal and from the present observation it is evident that the upwelling affects the near shore waters also.

We are thankful to Prof. E. C. La Fond for his help in analysing the Bathythermograph readings and also to Mr. P. V. Bhavanarayana for supplying the chemical data.

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INTERNATIONAL UNION OF CRYSTALLOGRAPHY: FOURTH GENERAL ASSEMBLY AND INTERNATIONAL CONGRESS

EVEN though the International Union of Crystallography has been of comparatively recent origin, having been founded only in 1947, it has already done great service to the promotion of crystallographic study and research at an international level. Its Fourth General Assembly and International Congress was held in Montreal, Qubec, Canada, from the 10th July to 17th July and was followed on the 18th and 19th by two symposia: one on "Physical Techniques of Crystallographic Interest" and the other on "Electron Diffraction Studies on Solids and Gases". The McGill University in Montreal acted host to the Congress and the technical sessions were held in "The Physical Sciences Centre" at Sherbrooke Street. A special evening lecture was given by the President, Prof. R. W. G. Wyckoff, in the auditorium of the University of Montreal.

The Congress was attended by crystallographers from over twenty nations and reached an all-time record of seven hundred and forty-two. The opening ceremony by the President took place in Moyse Hall on Wednesday, the 10th. Welcome addresses were presented on behalf of the Government of Canada and the National Research Council by Dr. E. W. R. Stracie, President of the National Research Council, on behalf of the McGill University by Dr. F. Cyril James, Principal and Vice-Chancellor, and on behalf of the University of Montreal by Monseigneur I. Lussier Rectov.

Over three hundred original research papers were presented at the technical meetings, and the entire July issue of *Acta Crystallographica* is devoted to the abstracts of papers presented at the Congress. Four concurrent sessions were held for the presentation of the contributed papers which were divided into seventeen sections depending on the subject-matter of the papers. General lectures were also given by leading crystallographers summarising the

present state of knowledge and possible future methods of attack, on some of the main problems of crystal chemistry and molecular configuration, studies of protein structures, clay minerals and imperfect structures. There was also an exhibition of commercial apparatus and books of crystallographic interest. The first *World Directory of Crystallographers* containing information about over two thousand crystallographers from fifty-four nations were also published and was on sale at the Montreal Meeting.

The closing General Assembly of the Union met on the 17th in Moyse Hall to organize and discuss the future program of the Union, and co-ordinate its various activities. The new Executive Committee elected is as follows: J. Wyart (France) (*President*); N. V. Belov (U.S.S.R.) and P. P. Ewald (U.S.A.) (*Vice-Presidents*); D. W. Smits (Netherlands), (*General Secretary*); R. W. G. Wyckoff (U.S.A.); O. C. A. Bastriansen (Norway); A. Guinier (France); F. H. Laves (Switzerland); C. H. MacGillavry (Netherlands); I. Nitta (Japan); and A. J. C. Wilson (U.K.).

The great success of the Conference could be attributed in a large measure to the Local Committee with Dr. W. H. Barnes (Canada), as its Chairman. By invitation of the Royal Society and the University of Cambridge, the next International Conference will be held at Cambridge, England, in August 1960.

GOPINATH KARTHA.

NEW MISSING LINK DISCOVERED

TO Zoologists, the recently reported discovery by the Galathea Expedition of the extraordinary deep-sea mollusk *Neopilina galatheæ* (H. Lemche, *Nature*, 23 February 1957), will seem even more incredible than the famous discovery in recent times of Latimeria, the living cœlacanth, even though the layman may see less of interest in the mollusk than in the fish. Latimeria, however, represents a group of fishes which survived into the Cretaceous period, and became extinct only some 70 to 90 million years ago; whereas the new-found mollusk represents a class that existed in the Cambrian to Devonian periods of the Paleozoic, and was supposed to have become extinct about 280 million years ago, when the cœlacanths were just beginning to branch off as a special side-group of the other lobe-finned fishes (crossopterygians). Latimeria, moreover, seems to be a conventional sort of cœlacanth, except for its salt-water habitat; but Neopilina is an obviously segmented mollusk, violating one of the general criteria by which mollusks are most readily known, their unsegmented body plan. Neopilina, of which 10 specimens and 3 additional shells were dredged up from a depth of 3,590 meters off the West Mexican Coast on 6 May 1952, has a fragile shell somewhat resembling that of a limpet, but there the similarity to any gastropod ends. The fossils of the class had already given evidence of symmetrically arranged pairs of shell muscles. The living animal exhibits segmentation in other significant features as well. There are five pairs of auricles that receive blood from the gills, one pair of auricles for each of the pairs of comb-like gills (ctenidia). There are also paired excretory organs, nephridia, again one pair for each of the five segments of the molusk's body. There may be other internal organs which are segmented in arrangement, but further study of the internal anatomy will be required to clarify such matters.

Neopilina represents a primitive form of mollusk intermediate between the amphineurans (chitons) and the cephalopods, but best placed, according to Lemche, in a distinct class, the Monoplacophora. Some of its fossil relatives which have even higher numbers of paired muscle scars on the inside of the shell may well have been the connecting links between the mollusks and the typically segmented annelid worms and arthropods. (*Science*, 1957, 126, p. 158.)

RAMAN EFFECT IN MIXTURES OF ANISALDEHYDE WITH PHENOL AND METHANOL

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I. Introduction

THE inductive and the mesomeric effects of a methoxy substituent on the phenyl ring are well known. Raman frequencies of methoxy aromatics provide sufficient indications regarding the abnormal effects of such substitutions. The effects of hydrogen bond formation in addition to the methoxy substitution on the vibrational frequencies of the p-methoxy benzaldehyde are presented here.

2. Experimental Technique

The Raman spectrum of anisaldehyde using Hg 4358 A.U. excitation was recorded with a Fuess Spectrograph and Hilger source unit. The spectrograph has a dispersion of 19 cm.$^{-1}$ per mm. in λ 4358 region. The exposure time of 20 minutes for recording an intense Raman spectrum of anisaldehyde was increased proportionally for mixtures, so that the lines of the aldehyde could be recorded with comparable intensity.

Two new lines, one at 140 cm.$^{-1}$ and another at 1699 cm.$^{-1}$ have been recorded for the first time. The other frequencies closely agree with those recorded by Kahovec and Kohlrausch.[1]

The frequencies associated with the vibrations of the phenyl group of the aldehyde are 640, 988, 1008, 1161 and 1600 cm.$^{-1}$ The line at 1161 cm.$^{-1}$ is due to the vibrations of C-H bond in the plane of the ring.

Some of the relevent frequencies of a few ring compounds are given in Table I.

By a comparative study of Table I, the frequencies associated with different bonds of anisaldehyde can be identified easily. Benzene has no lines at about 1200 cm.$^{-1}$ By the methoxy substitution, a line at 1244 cm.$^{-1}$ makes its appearance. Therefore, this appears to be the line arising due to the vibrations of C-O connecting the phenyl ring to the methoxy group.

The line at 1197 cm.$^{-1}$ in benzaldehyde has been assigned by the author[2] to the vibrations

Table I

1		Benzene	..	1178	..	..	1478	1584 1600	..
2		Benzaldehyde	..	1159	1197	..	1448 1493	1591	1694
3		Methoxy Benzene	..	1177	..	1244	1452	1587 1603	..
4		Anisaldehyde	..	1161	1216	1263	1427 1461	1577 1600	1699

3. Results and Tentative Assignments

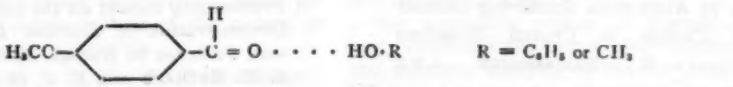
The Raman frequencies of anisaldehyde are tabulated below with the conventional notations.

140(1), 190(1 b), 276(2), 332(1), 370(1), 602(2 b), 640(3), 720(1), 746(2), 835(3), 857(3), 988(2 s), 1008(0), 1161(6), 1216(4), 1263(4), 1317(3), 1393(0), 1427(5), 1461(2), 1577(4), 1600(8), 1681(8), 1699(5), 2957(4), 2989(4), 3024(3).

of C-C bond linking the aldehydic group to the phenyl ring. The frequencies of anisaldehyde are in general higher than the corresponding ones in benzaldehyde. As such the line at 1216 cm.$^{-1}$ in anisaldehyde can correspond to a line at 1197 cm.$^{-1}$ in benzaldehyde. Therefore, the line at 1216 cm.$^{-1}$ in anisaldehyde can be assigned to C-C bond connecting the aldehydic group and the phenyl ring of the aldehyde.

4. Hydrogen Bond Formation

In order to create opportunities for the hydrogen bond formation, anisaldehyde was mixed with acceptor solvents like phenol and methanol



The frequency shifts observed for anisaldehyde hydrogen bonded to phenol or methanol are given in Table II.

to the change in the polarizability of the environment of each anisaldehyde molecule. In the case of frequency 1600 cm.$^{-1}$ there is an initial reduction by 3 cm.$^{-1}$ and then at concentration ratio 1 : 4 a further reduction of 4 cm.$^{-1}$ is observed. This probably means the frequency shifts in this case are entirely due to polarizability changes in the environment and hydrogen bonding apparently does not affect this frequency. On the other hand, polarizability changes do not seem to have affected the frequency at 1263 cm.$^{-1}$

Table II

Mixtures of anisaldehyde with phenol and methanol

Link	Frequencies of Anisaldehyde	Frequencies in Phenol, Ratio by volume Aldehyde : Phenol			Frequencies in Methanol, Ratio by volume Aldehyde : Methanol		
		1 : 1	1 : 2	1 : 4	1 : 1	1 : 2	1 : 4
C–H	1161	1165	1165	1164	1169	1169	1167
C–C ald. ring	1216	1222	1222	1222	1223	1223	1222
C–OCH_3	1263	1270	1270	1270	..	..	..
–C–H	1427	1432	1432	1433	..	..	..
C–C (ring)	1577	1572	1572	1562	..	..	..
	1600	1597	1593	1593	..	..	..
C=O	1681	1662	1662	1657	1678	1678	1678

Due to hydrogen bond formation, C = O which is the direct participant in the bond formation, gets weakened, as shown by the decrease in frequency of the vibration of C = O. With the aldehyde-phenol ratio going up to 1 : 2, the frequency is lowered by 19 cm.$^{-1}$ on further increasing the ratio up to 1 : 4, there is a further reduction of 5 cm.$^{-1}$ only. With the exception of the frequency at 1600 cm.$^{-1}$, all other frequencies exhibit a similar behaviour, the magnitude of the variations being different in each case. It can be postulated that the first steep variation in the frequency is due to hydrogen bond formation, and the further small reduction or increase in the frequency, is due

When the proportion of the solvent was increased more than four times, critical opalescence appears to set in, and the entire spectrum gets blackened.

The author expresses his sincere thanks to Prof. S. Bhagavantam for his guidance throughout the progress of this work.

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LETTERS TO THE EDITOR

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THE USE OF ANOMALOUS SCATTERING WITHOUT PHASE CHANGE IN CRYSTAL STRUCTURE ANALYSIS

Many novel methods have recently been suggested for the determination of the phases in non-centro-symmetric structures. These can in general be classified into two categories: (i) those in which isomorphous crystals are used, and (ii) those in which one set of atoms in the crystal scatters the incident radiation anomalously with a change of phase. By the use of two isomorphous crystals, the determination is ambiguous to the extent that two values can be assigned for the phase of each reflexion (Bijvoet[1]). This ambiguity can however be resolved by the use of the double-isomorphous replacement method (Harker[2]). In method (ii) also (where the intensities of the hkl and $\bar{h}\bar{k}\bar{l}$ reflexions are used to determine the phases) a similar ambiguity exists. Here again it can be overcome by the use of two isomorphous crystals along with the anomalous scattering technique (Ramachandran and Raman[3] and Okaya and Pepinsky[4]).

Recently, the present writers[5] had occasion to solve a centro-symmetric structure ($KMnO_4$) using two radiations, one on either side of the absorption edge of one of the atoms (Mn). From a knowledge of the differences in the scattering factors for the two wavelengths and the position of the anomalously scattering atom, it was possible to determine the signs of more than half the total number of reflexions. This method practically amounts to the isomorphous replacement technique. In this note the writers wish to draw attention to the fact that wherever one uses the isomorphous replacement method for the determination of non-centro-symmetric structures, one could substitute the method of anomalous scattering without change of phase.

Thus it should be possible to determine the phases in an acentric case by an analogue of Harker's method by using three radiations, two of which have wavelengths that are respectively scattered anomalously (without change of phase) by two kinds of atoms that occupy different sites in the structure. In practice only relatively simple structures with favourable scatterers in them will prove amenable to solution by this method.

If two incident wavelengths on each side of and close to the absorption edge of one of

the atoms be used, since for one of the wavelengths there is only an amplitude change, while for the other there exist changes both in phase and amplitude, the method suggested by Ramachandran and Raman for isomorphous crystals (*loc. cit.*) could be directly applied for the unequivocal determination of the phases of non-centro-symmetric crystals.

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AN INTERPRETATION OF THE VERTICAL MAGNETIC ANOMALIES OVER THE KODUR MANGANESE BELT

THE high magnetic character of the Indian manganese ores was first brought to light by Fermor,[1] who further indicated the possibility of finding new deposits by magnetic prospecting.

Very recently we have carried out extensive investigations with the vertical magnetometer over the Kodur manganese belt in the Srikakulam District (Andhra State). These were followed by laboratory investigations of the magnetic properties of these manganese ores. The results of the susceptibility measurements showed that the manganese samples exhibited susceptibilities over a wide range. Further the variation of susceptibility with field strength in the region of 0-1,000 oersteds was different in most cases. Most of the ore samples exhibited strong ferromagnetic characteristics and all of them showed only one susceptibility maximum, which may indicate the presence of a single ferromagnetic mineral responsible for the magnetism of the ores. The high values of the remanence and coercivity of the ore samples indicated that the ores were susceptible to high remanent magnetism.

Chemical analysis of the ore samples showed that most of the samples collected contain moderate to high percentages of manganese and fair amounts of iron. The susceptibility values appeared to bear no relation with the individual amounts of iron or manganese. It was generally observed from the susceptibility measurements that high susceptibilities were associated with samples containing mangan-magnetite and Vredenburgite, whereas samples rich in the hydrated oxides like psilomelane possessed low susceptibilities.

The normative values of mangan-magnetite and Vredenburgite were also calculated from the chemical analysis of the ore samples. The relation between the normative percentages of $(MnFe)_3O_4$ and susceptibility was found to be almost linear. Extrapolation of the statistically best fitted line gave rise to a value of $150{,}000 \times 10^{-6}$ (C.G.S. units) for cent. per cent. normative $(MnFe)_3O_4$, which was found to be in the range of susceptibilities quoted by Mason[2] for hausmannite, jacobsite series.

It was finally concluded, therefore, that the presence of minerals like mangan-magnetite and Vredenburgite (which are almost identical with one another) resulted in the high magnetic character of some ore samples. The variation in percentage of these metamorphosed minerals was the cause of the wide range of magnetic properties exhibited by these ores. This could hence explain the wide variation in the vertical magnetic anomalies over this area.

Further details of the above investigations will be published elsewhere.

The authors wish to acknowledge their thanks to Professors C. Mahadevan and G. Gopala Rao for facilities provided. One of us (V. L. S. B. S.) is also thankful to the Ministry of Education, Central Government, for the award of a fellowship.

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USE OF COMMERCIAL ELECTROLYTIC COPPER ELECTRODES IN SPECTROGRAPHIC ANALYSIS

IMPORTED copper electrodes of spectrographic purity have been in use at this Institute, for the determination of boron and manganese in soils and plants, with bismuth as the internal standard. In view of recent import difficulties, the possibility of using commercial electrolytic copper known for its high purity was explored.

Spectrographic comparison of commercial electrolytic and pure copper rods made by means of a Hilger Large Quartz Spectrograph, using a direct current arc, showed absence of boron and

bismuth lines in all rods, while manganese was barely detected in some rods of both variety suggesting the presence of only minute traces of it. Impurities detected were nickel, silver and lead, the lines being somewhat stronger in the commercial electrolytic copper. Stɸp sector studies were in agreement with these observations. The regions near the lines used in regular work, *viz.*, B 2497·73, Mn 2794·82 and Bi 2897·98 were free from interference of impurity lines. No extraneous element effects were observed which confirms the finding of Smith[1] for impurity concentrations of less than 1%.

According to Eichrodt and Schloen[2] purity of electrolytic copper is 99·95 to 99·96%, the total metallic impurities being invariably less than ·01%, and the individual impurities less than ·002%. Among these impurities, boron and manganese are absent, while the bismuth content ranges from a trace to ·0002%. These facts are corroborated by spectrographic investigations. In view of the above, the use of commercial electrolytic copper for the analysis of boron and manganese could be safely recommended.

The author's thanks are due to Dr. B. P. Pal for offering facilities and encouragement during the course of this work.

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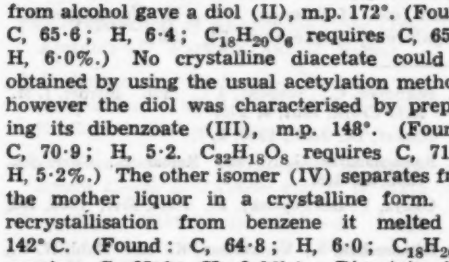
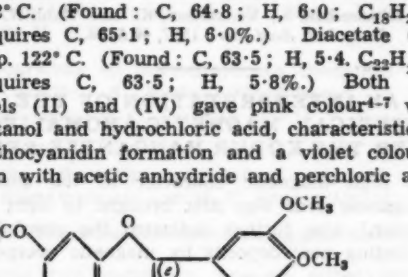
SYNTHESES OF CRYSTALLINE LEUCOANTHOCYANIDINS RELATED TO MOLLISACACIDIN

As a part of scheme of investigation of leucoanthocyanidins and phlobatannins, syntheses of a number of crystalline leucoanthocyanidins, hydroxylated on the pattern of Kæmpferol, Fisetin, Quercetin, Myricetin, etc., was undertaken in this laboratory. Syntheses of a few crystalline leucoanthocyanidin derivatives have already been reported by Kulkarni and Joshi.[1] Their method is extended for the syntheses of 7 : 3' : 4'-trimethoxy-flavan-3 : 4-diols described in this communication. Incidentally it was also the objective to synthesise a leucoanthocyanidin which is likely to be identical with the one recently isolated by Keppler[2] from *Acacia mollissima*.

7 : 3' : 4'-Trimethoxy dihydro-flavonol (I), m.p. 143° C., required for the purpose was prepared by the procedure described by Kulkarni and Joshi.[3] On reduction of the above dihydroflavonol with lithium aluminium hydride, a mixture of flavan-3 : diols, m.p. 125°-130°, was obtained. On careful treatment of the mixture with aqueous alcohol, part of it went into solution. The residue on crystallisation from alcohol gave a diol (II), m.p. 172°. (Found: C, 65·6; H, 6·4; $C_{18}H_{20}O_6$ requires C, 65·1; H, 6·0%.) No crystalline diacetate could be obtained by using the usual acetylation methods, however the diol was characterised by preparing its dibenzoate (III), m.p. 148°. (Found: C, 70·9; H, 5·2. $C_{32}H_{18}O_8$ requires C, 71·1; H, 5·2%.) The other isomer (IV) separates from the mother liquor in a crystalline form. On recrystallisation from benzene it melted at 142° C. (Found: C, 64·8; H, 6·0; $C_{18}H_{20}O_6$ requires C, 65·1; H, 6·0%.) Diacetate (V), m.p. 122° C. (Found: C, 63·5; H, 5·4. $C_{22}H_{24}O_8$ requires C, 63·5; H, 5·8%.) Both the diols (II) and (IV) gave pink colour[4-7] with butanol and hydrochloric acid, characteristic of anthocyanidin formation and a violet colouration with acetic anhydride and perchloric acid.



(I) R = H



(II) R = H mp. 172°
(III) R = − COC_6H_5
(IV) R = H, mp. 142°
(V) R = − $COCH_3$

On the basis of the hypothesis previously postulated by Kulkarni and Joshi,[1] regarding conformations of flavan-3 : 4-diols, (IV) is assigned (2*e*, 3*e*, 4*a*) conformation and its isomer (I) is assigned (2*e*, 3*e*, 4*e*) conformation. Keppler has shown that mollisacacidin trimethyl ether is a *cis*-diol and is identical with the one synthesised by him from the natural fustin. According to Kulkarni and Joshi,[3]

C_3-OH of fustin is equatorial and hence mollisacacidin is assigned (2*e*, 3*e*, 4*a*) conformation—the same assigned to synthetic diol (IV). Further we believe that mollisacacidin ether and the racemate (IV) are identical but the discrepancy in melting point may be due to either (1) Keppler's diol is a mixture (our mixture has a melting point range 125°-130° C.), or (2) the racemate (IV) and the optical antipode of Keppler have different melting points as is the case with synthetic and natural mellacacidin derivatives.[9]

Our thanks are due to the Bombay State Industrial Research Committee who have granted a Fellowship to one of us (K. R. C.).

Chemistry Department, Institute of Science, Bombay-1, *August* 12, 1957.

K. R. CHANDORKAR.
A. B. KULKARNI.

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A PRELIMINARY NOTE ON A METHOD FOR THE CYTOCHEMICAL DEMONSTRATION OF SUCCINIC DEHYDROGENASE IN HUMAN LEUCOCYTES

SAMPLES of blood, heparinised and non-heparinised, were mixed with buffer substrate solution with a p-nitrophenyl-substituted ditetrazole (Nitro B.T.), incubated at 37° C. for 1 hr. and centrifuged.

Smears made from the buffy coat were fixed with absolute alcohol, dried and counterstained with saffranin '0'.

In some of the polymorphonuclear cells succinic dehydrogenase activity was indicated by the formation of blue formazan, either as fine granules or thin rods.

The method in detail will be published in the near future, and is being applied in the study of succinic dehydrogenase patterns in various leucocytes in health and disease.

Dept. of Anatomy, T. N. Medical College, Bombay-8, *September* 5, 1957.

E. J. DE SOUZA.
S. N. KOTHARE.

A PRELIMINARY REPORT ON THE CYTOCHEMICAL DEMONSTRATION OF SUCCINIC DEHYDROGENASE PATTERNS IN HUMAN SPERMATOZOA

SEMEN from normal healthy volunteers was mixed with buffer substrate solution containing a p-Nitrophenyl-substituted ditetrazole (Nitro B.T.) and incubated at 37° C. for 4 hr. The mixture was then centrifuged and smears made from the deposit were fixed in absolute alcohol and counterstained with saffranin '0'.

Under the oil immersion lens, the succinic dehydrogenase as indicated by the presence of blue formazan granules was detected in the mid-piece in large amount and sparingly in the head.

The abnormal forms also showed this enzyme but the pattern of distribution differed considerably.

The detailed patterns of various forms will be published very shortly.

Dept. of Anatomy, Topiwala National Medical College, Bombay, *September* 13, 1957.

S. N. KOTHARE.
E. J. DE SOUZA.

THE PREPARATION OF ANHYDROUS CERIC OXY-ACETATES

THE higher valency state of cerium is maintained throughout the course of the thermal decomposition of ceric acetate.[1] In the absence of light and moisture, when ceric acetate is heated in vacuum, different compounds are formed at certain temperatures. Of the compounds prepared, one has been obtained at 65° C. and the other at 100° C. Weighed quantity of the anhydrous ceric acetate whose oxide content had been determined previously was taken for each of the experiments recorded in Tables I and II. The oxide content of the compound formed either at 65° C. or at 100° C. from a definite amount of ceric acetate could therefore be calculated. The molecular formula of the compound has been computed as that part by weight which would give on ignition 172 parts or its multiple of ceric oxide CeO_2. The ceric content in the compound was estimated by adding a definite weight of the compound to a known amount of ferrous ammonium sulphate in 5 N H_2SO_4 and determining the unoxidised iron left by titrating against standard permanganate solution, blank experiment indicating that the amount of acetate present did not interfere. The acetate content was estimated as described previously by hydrolysis (*loc. cit.*).

TABLE I

Temperature: 65° C.
Mol. Wt. (Theoretical): 650·2
Mol. Formula: $Ce_2O(C_2H_3O_2)_6$

Wt. of Ceric Acetate	Wt. of the comp. obtained	Mol. wt. computed	Ceric content		Acetate content	
			Calc.	Found	Calc.	Found
0·0254	0·0228	653·6	0·0098	0·0096	..	..
0·0390	0·0350	654·2	0·0151	0·0152	..	..
0·0240	0·0214	651·4	..	..	0·0116	0·0111
0·0614	0·0548	652·2	..	..	0·0298	0·0286

TABLE II

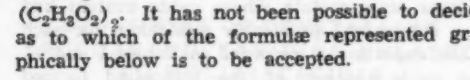
Temperature: 100° C.
Mol. Wt. (Theoretical): 274·1
Mol. Formula: $CeO(C_2H_3O_2)_2$

Wt. of Ceric Acetate	Wt. of the comp. obtained	Mol. wt. computed	Ceric content		Acetate content	
			Calc.	Found	Calc.	Found
0·0290	0·0218	275·7	0·0111	0·0112	..	..
0·0252	0·0190	274·6	0·0098	0·0100	..	..
0·0284	0·0212	272·5	..	..	0·0091	0·0092
0·0312	0·0232	271·5	..	..	0·0100	0·0099

The analytical data in Table I show that the compound formed at 65° C. is diceric mono-oxy hexa-acetate, the molecular formula of which is represented graphically below:

$$(C_2H_3O_2)_3 \equiv Ce\text{–}O\text{–}Ce \equiv (C_2H_3O_2)_3$$

The data in Table II suggest that the compound formed at 100° C. is anhydrous ceric oxyacetate having the molecular weight 274·1, indicating for the empirical formula Ce.O $(C_2H_3O_2)_2$. It has not been possible to decide as to which of the formulæ represented graphically below is to be accepted.



On exposure to moisture, the two oxyacetates undergo rapid reduction to cerous state.

Further investigation is proceeding.

Dept. of Chemistry, Ravenshaw College, Cuttack-3, *September* 13, 1957.

D. PATNAIK.
B. SAHOO.

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POTENTIATION OF HISTAMINE RESPONSE OF GUINEA-PIG ILEUM BY SERPENTINE

CHATTERJEE AND HAUSLER[1] have reported anti-acetyl choline and antihistaminic activity of a total alkaloidal preparation of *Rauwolfia serpentina* on guinea-pig ileum. They also observed in a few experiments during the phase of recovery a slight potentiation.

On testing serpentine, one of the alkaloids of *R. serpentina*, we found that it consistently potentiated the histamine response of guinea-pig ileum without affecting the acetyl choline response. Arunlakshana *et al.*[2] have investigated the possible mechanism of such a potentiation with semicarbazide, some other carbonyl compounds and some guanidines, and have ascribed it to antihistaminase activity. We have tried to demonstrate an antihistaminase activity of serpentine, to explain its potentiation of histamine response on guinea-pig ileum.

Experiments were carried out in a 10 c.c. intestinal bath containing aerated magnesium-free Tyrode solution at pH 7·6 at 35 to 36° C., all additions of histamine being washed off in 30 seconds. Control responses of 0·02 or 0·03 μg./c.c. histamine base (used as its acid phosphate) acting for 30 seconds were obtained

at constant intervals. Thereafter responses to the same dose of histamine were obtained in the same way but with a previous addition of a concentration of serpentine. This was repeated till maximum potentiation of histamine response was obtained with the particular concentration of serpentine. Then serpentine was omitted and repeated histamine responses were elicited till the response returned to control level (Fig. 1). Serpentine was tried in the

FIG. 1. Potentiation of histamine response of guinea-pig ileum with serpentine. 10 c.c. Tyrode Bath, H=0·02 µg./c.c. histamine, S=10^{-8} serpentine. Bath washed 30 seconds after each histamine addition.

following concentrations of the base (used as hydrochloride solution) 10^{-9}, 10^{-8}, 10^{-7}, 10^{-6} g./c.c. The potentiation was measured in terms of equivalent dose of histamine. 10^{-9} g./c.c. serpentine produced minimal potentiation ranging between 1·3 to 1·4 times the control. 10^{-8} and 10^{-7} g./c.c. serpentine produced potentiation ranging between 1·4 and 2·2. 10^{-6} g./c.c. serpentine produced less marked potentiation than 10^{-7}. Atropinisation did not affect the potentiation.

When 10 mg. of a histaminase preparation (Torantil, Hoechst) was incubated for ½ hr. and 1 hr. at 37° C. in an atmosphere of oxygen and continuously shaken with 10^{-6} g./c.c. histamine as substrate with and without serpentine 10^{-6} g./c.c. in 10 c.c. of phosphate buffer at pH 7·2, the destruction of histamine by histaminase, tested on the guinea-pig ileum after destruction of histaminase by boiling, was definitely inhibited with serpentine. On an average 17·6 and 16·5% histamine was destroyed respectively in ½ hr. and 1 hr. when serpentine was present but 38 and 70% histamine was destroyed respectively when no serpentine was added.

The possible antihistaminase activity of this *Rauwolfia* alkaloid may throw some light on the mechanism of action of *Rauwolfia*. It can certainly explain some of its histamine-like effects on gastro-intestinal system, nasal mucosa and bronchi. Further work is in progress.

We are thankful to Dr. B. P. Ghosh of Gluconate Co., Calcutta, for generous supply of serpentine and to Hoechst Fedco, Ltd., Bombay, for the supply of Torantil.

Dept. of Pharmacology, K. S. SACHDEV.
B. J. Medical College, RANITA AIMAN.
Poona, *September* 19, 1957.

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COLCHICINE-INDUCED TETRAPLOIDY IN *IBERIS AMARA* L.

BALI AND TANDON[1] have recently published a preliminary account of the work done on colchicine-induced tetraploidy in *Linaria vulgaris*. The present paper is a brief report of a similar type of work on *Iberis amara* L. (Rocket candytuft) which is an important annual garden plant commonly grown for its showy bunch of white flowers.

The apical growing points of seedlings with 6 to 8 leaves were covered with small cotton wads which were kept moist with aqueous colchicine solution. The treatments employed were 0·05, 0·10, 0·20 and 0·30% colchicine for 6 and 12 hr. Fifteen plants were used in each treatment. The most successful treatments from the point of view of survival of seedlings and the production of polyploids were found to be 0·10 and 0·20% colchicine applied for 6 or 12 hr. The leaves which came out just after the treatment were small, thick and abnormal in shape. The subsequent leaves were like those of the untreated plants except that they were larger and slightly thicker than diploid leaves. The stem of the mature tetraploid plants was thicker than that of the diploid. The mature leaves of the tetraploids had larger and more widely spaced stomata than diploids. The guard cells of the stomata of the former average 48·59 µ in length and 15·80 µ in width as compared with an average length and width of 29·42 and 10·93 µ respectively, in the latter. The average number of stomata for the $2n$ and $4n$ were 182·76 and 69·29 per sq. mm. respectively. Similar observations were recorded with reference to the number and size of epidermal cells in $2n$ and $4n$ plants. The diploid and tetraploid plants started flowering at almost the same time. The tetraploids had conspicuously large flowers (Plate I, Figs. A and B). The percentage of pollen fertility was as high as 92 in diploids as well as tetraploids. The pollen grains of the tetraploid were, however, larger than those of the diploid. There was

practically no difference in fruit setting between the $2n$ and $4n$ plants. The fruits in $4n$ plants were almost double in size in comparison with those of the diploid. The seed setting in the tetraploid population was rather poor. Although the number of ovules per ovary was two in both the cases, the average number of seeds per fruit was two and one in the diploid and tetraploid respectively. Some of the fruits collected from the $4n$ population were either seedless or had shrivelled seeds only. The seeds of the tetraploid plants were larger than those of the diploid.

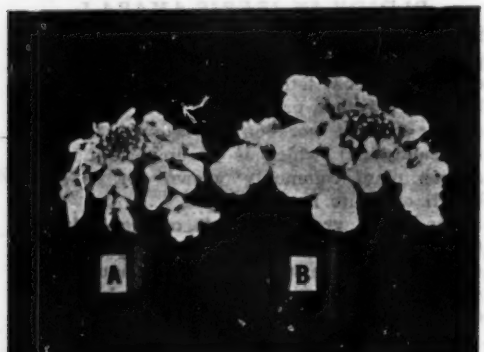

PLATE I

A. Part of flowering shoot of the diploid.
B. Part of flowering shoot of the tetraploid.

All the colchicine-treated plants were cytologically analysed. Squashes of pollen mother-cells were stained with propionocarmine. Meiosis in the diploid *Iberis amara* L. has already been reported by Tandon and Bali.[2] The haploid chromosome number in the species was confirmed as $n = 7$. The tetraploid plants showed $n = 14$. Most of the possible configurations ranging from fourteen bivalents to seven quadrivalents at diakinesis were seen in the preparations of the $4n$ plants. Majority of the tetraploid plants showed regular distribution of chromosomes at anaphase I. The metaphase II plates showed $14 + 14$ distribution but in two cases $12 + 16$ distribution was also observed. The number of microspores per pollen mother-cell was four (normal tetrads), the same being true for the diploid.

The presence of conspicuously large flowers in the artificially induced tetraploid *Iberis amara* L. suggests a strong possibility of selection of a desirable type for introducing in the horticultural trade. Although the seed setting in the tetraploid population was low but this handicap can be easily overcome by leaving a larger number of plants for seed collection.

We are thankful to Prof. P. Maheshwari, Head of the Department of Botany, University of Delhi, for the facilities and encouragement.

Dept. of Botany, S. L. TANDON.
University of Delhi, P. N. BALI.*
Delhi-8, *September* 16, 1957.

* Lecturer in Botany, Hansraj College, Delhi-8.

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DACTYLISPA DILATICORNIS DUV. A LEAFMINER OF PADDY

Dactylispa dilaticornis was observed to be doing considerable damage to paddy in association with *Hispa armigera*, during the monsoon season of 1956, round about the Main Farm, Rajendranagar, Hyderabad. The authors, while working on paddy pests, came across a plot heavily infested by *Hispa armigera*, wherein some mined paddy leaves were glassy white in colour and apparently without frass deposit, unlike those formed by *Hispa armigera*. On examination they were found to be those formed by grubs of *Dactylispa dilaticornis*.

Maulik[1] reports that the species was found near the roots of rice plants and also mining leaves of *Panicum* sp. and "dabi" grass at Pusa.

The blood red grubs of *D. dilaticornis* form full depth ophistigmatonomes, (linear-blotch mines) which are transparent and glassy white in colour. The frass is pushed towards the base, keeping the rest of the mine almost clean unlike *H. armigera* where the mines are dirty white to brownish-white in colour and the frass is distributed irregularly throughout. The mine formed by *D. dilaticornis* is shorter, about 3-4" only and invariably the ends are rounded up which are easily distinguished from mines formed by *H. armigera* where the ends of the mines are irregular.

Eggs are laid inside the leaf-tissue in lines. The grubs start mining immediately after hatching. The grubs are pink-red in colour in the earlier instars turning blood red when full grown. The prothoracic segment is strongly chitinised with a medio-dorsal line. The brown head capsule is embedded inside the prothorax. The 9th abdominal segment which is light brown in colour bears two spinules, projecting towards the anal segment. The full-grown grub is 4·5 to 5 mm. long and 2 mm. broad.

The larval period lasts for 8-10 days. Pupation takes place outside the mine. In fields the pupæ were seen sticking on the stems of paddy above the water-level. When they fall down they float on water and hold on to any nearby plant to which they again stick. The pupa is pink red in colour. It is 4 to 4·5 mm. long and 1·5 to 1·8 mm. broad. The pupal period lasts for 4-6 days.

The adult is a tiny black beetle, smaller in size than *H. armigera*. The elytra are metallic greenish-blue and densely covered by spines. The head is rugose and pubescent, the hair being white in colour. The prothoracic plate is triangular in shape, bearing five black spines laterally on each side. The posterior-most spine is stout and is also the longest of all.

The feeding habits of the adult is the same as that of *H. armigera*. An unidentified chalcid was found to parasitise the grubs.

D. dilaticornis is common on *Cynodon dactylon* and on a species of *Panicum*. From March to May grubs are found on *Cynodon*. The adults move on to paddy after July and cause damage to young paddy together with *Hispa armigera*.

Division of Entomology, Hyderabad, M. Q. KHAN.
Agril. Research Station, Dhadesugur, S. N. KADAPA.
Mysore State, *September* 24, 1957.

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OCCURRENCE OF *BACTRONOPHORUS THORACITES* (GOULD), A MARINE WOOD BORER, IN BOMBAY

THE occurrence of *Bactronophorus thoracites* from India as a pest on living and dead trees in the mangrove swamp forests of the 24-Parganas Forest Division in the Sunderbans, West Bengal, observed by Dr. M. L. Roonwal,[1] Director, Zoological Survey of India, has been noted with great interest. Since no Teredinid borers have so far been known to attack living trees, this is perhaps the first record in this respect. Nagabhushanam (*vide* Roonwal, 1954, 98), mentions its occurrence in Visakhapatnam harbour (Andhra State), on the bottoms of catamarans. In no other place in India this species has been reported to be as destructive to living trees or timber under seawater as in the Sunderban Swamp Forests of West Bengal.

Two species of the genus *Bactronophorus*, namely, *B. thoracites*, Gould and *B. australis*, Wright, have been recorded by Bartsch[2] (1922) in his *Monograph of American Shipworms*. Elsewhere, it has been recorded from the Philippines, Australia, Tavoy in Burma and Singapore (Malaya).

It is interesting to note that a single specimen of *Bactronophorus thoracites* (Gould) was obtained for the first time during May 1955, from a beam of *Tectona grandis*, from Sewree Timber Pond, on the east coast of Bombay (Island). It measured about 100 mm. long and 12·5 mm. in width. It has a close resemblance to *Teredo* in its external features, except that its pallets bear typical stilt-like processes at the ends (Fig. 1). Later collections in the same locality, brought out the occurrence of this genus twice, during the year 1956, once during October and again during November, though only a single specimen was collected in each month. These two specimens appeared remarkably stunted in growth, each measuring about 44·5 mm. long and 12·5 mm. in breadth (Fig. 1).

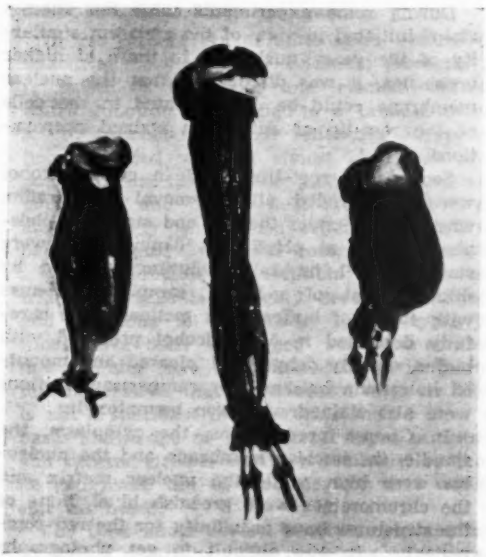

FIG. 1

They were carefully removed from fairly hard timbers, one from *Tectona grandis* and the other from *Terminalia* sp.

Since their first record from living mangrove trees (West Bengal), subsequent efforts were made to collect them from mangrove in the Southern and Northern parts of Bombay (Island), but without success. However, the dead stems of the mangrove trees were generally found to be severely infested by species

of *Bankia* and *Teredo*. This indicated a great affinity of shipworms to dried mangrove trees.

Wood Preservation Centre, (F.R.I., Dehra Dun), V. C. PALEKAR.
Dept. of Zoology, Institute of Science, Bombay, *July* 24, 1957. D. V. BAL.

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THE NUCLEAR MEMBRANE OF THE CELLS OF THE ROOT-TIP OF *ALLIUM CEPA*

IT was generally believed[1] that the nucleus of plant cells is separated from the cytoplasm only by a phase boundary. Recent investigations with the electron microscope[1] show that like the nuclei of animal cells, plant nuclei have also a fenestrated double-walled membrane.

During some experiments with the Giemsa stain[2] initiated in view of the apparent similarity of the yeast nucleus[3-6] to those of higher organisms, it was discovered that the nuclear membrane could be demonstrated in the cells of the root-tip of *Allium* in stained preparations.

Sections of root-tips fixed in acetic alcohol were downgraded after removal of paraffin, washed well under the tap and stored in phosphate buffer at pH 7 for 10 min. They were stained for 1 hr. in a solution prepared by diluting 5 ml. of a B.D.H. sample of Giemsa with 45 ml. of buffer. The sections were carefully destained in 50% alcohol prepared with buffer, quickly dehydrated, cleared and mounted in canada balsam. For comparison, sections were also stained with iron hæmatoxylin.

In Giemsa preparations, the cytoplasm, the spindle, the nuclear membrane and the nucleolus were blue, while the nuclear matrix and the chromosomes were greenish blue. None of the structures have an affinity for the red component. It was difficult to get photographs showing a contrast between the chromosomes and the spindle.

A distinct nuclear membrane could be seen in cells stained with Giemsa (Photo 1) as well as hæmatoxylin (Photos 2 & 3). While it is thin in the latter (Photos 2 & 3), it is relatively thick in the former (Photo 1). The reactions of the spindle and the cell plate to these two stains are different. Whereas the phragmoplast[7] appears deeply stained with the cell plate as a distinct unstained streak in Giemsa (Photo 4), both are stained by hæmatoxylin (Photo 5) in a shade lighter than that of the nucleus.

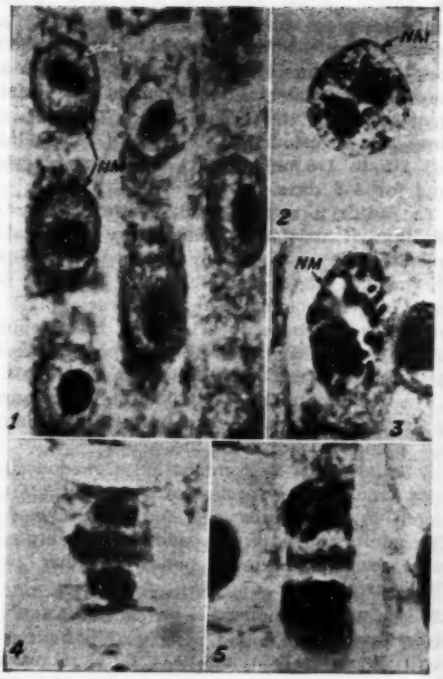

PHOTO 1. Giemsa, ×ca 1,300. PHOTO 2. Hæmatoxylin, ×ca 1,200. PHOTO 3. Hæmatoxylin, ×1,200. PHOTO 4. Giemsa, ×ca 750. PHOTO 5. Hæmatoxylin, ×ca 1,200.

A perusal of Photo 4 would reveal that it is the achromatic figure that is prominent in Giemsa. Since some experiments show that when the cells are hydrolysed in N.HCl at 60° C., their reaction to Giemsa is different, an attempt is being made to elucidate whether the Giemsa stain could be used for the study of the achromatic figure as well as the chromosomes. Such information would be interesting in the context of the unusual popularity of the Giemsa stain among microbial cytologists.[8-10]

Cytogenetics Lab., Dept. of Biochem., Indian Institute of Science, Bangalore-3, *October* 15, 1957. S. SUBRAMANYAM. M. K. SUBRAMANIAM.

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REVIEWS

A History of Luminescence from the Earliest Times Until 1900. By E. Newton Harvey. (Published by the American Philosophical Society.) Pp. 692. Price $ 6.00.

The author of this volume engaged himself for many years in investigations on the production of light by luminous organisms. The results of these researches have found publication in numerous original papers and in a series of monographs. The book by him entitled "Living Light" published by the Princeton University Press in the year 1940 is a particularly attractive exposition of the subject. In the course of his studies, Prof. Newton Harvey had to delve deeply into the literature of the subject, and the present volume describes the results of these explorations. It covers a much wider field than that of animal luminescence and indeed surveys the entire literature of luminescence of living as well as of non-living material, including in the term every kind of light emission except thermal radiation.

Part I of the book is a historical survey of the subject from the remotest times up to the end of the 19th century. Part II deals in detail with the luminescence of non-living material under various heads, *viz.*, electroluminescence, phosphorescence, thermoluminescence, tribo-, piezo-, cristallo-, lyo-luminescence, fluorescence, radio-luminescence and finally chemiluminescence. Part III deals with bio-luminescence under three heads, *viz.*, shining fish, flesh and wood, phosphorescence of the sea, and animal luminescence. The book contains a selected bibliography covering some sixty pages of the work, and also some illustrations of historic interest.

The spirit in which the book has been written is indicated by the quotation on the title page: "It is a noble employment to rescue from oblivion those who deserve to be remembered." It may be remarked in this connection that the present pace of scientific research is such that for a paper to be remembered and quoted after two decades is rather exceptional. But the extraordinary interest of the subject and the fact that its origins go back to the beginnings of science appears to justify the loving labour which the author has devoted to his self-imposed task. The book is a mine of information to those interested in the history of science. Reading it through, one recaptures the enthusiasms of the past, as for example, the enormous furore created by the discovery of the Bolognian stone at the beginnnig of the 17th century. One also comes across in its pages, the names of men the memory of whose achievements does not need to be rescued from oblivion, as for example, Robert Boyle, Sir George Stokes, and the Becquerels. The work of such men will always be remembered, since they were the great path-finders.

The author of the book as well as the American Philosophical Society are to be heartily congratulated on this scholarly publication which will remain of permanent value to the historian of science.

C. V. R.

Industrial Electronics Handbook. By Dr. R. Kretzmann. (Philips Technical Library), 1956. Pp. 298. Price 42 *sh.*

In the present era of automation, control of industrial machinery and industrial processes is relegated to electronic and electric devices which function according to a predetermined set of instructions. High reliability of operation combined with an almost inertialess response of these devices have gained them a great popularity, and in the field of application of atomic energy where many operations have to be manipulated by remote control, their use is a rule rather than an exception. Today, industrial electronics is a highly developed subject and according to the needs, special types of tubes have been developed and innumerable new circuits have been invented. It is therefore imperative, that an industrial engineer who is not a specialist in electronics should have a basic knowledge of the several types of tubes and control circuits that are available, so that he can make use of such devices that would suit his needs.

The book under review provides relevant information regarding basic principles of a number of electron tubes and circuits which are widely used in various applications. Part I of the book is principally devoted to a consideration of the fundamental aspects of several gas-filled and vacuum tubes and their basic circuits. Rectifying tubes, thyratrons, ignitrons, excitrons, voltage stabilisers, photocells, trigger tubes, cathode ray tubes and vacuum tubes come under its purview.

In Part II electronic relays, electronic counting circuits, electronic timers, industrial rectifier

circuits, electronic dimming of lamps, circuits for speed and temperature control, electronic control of resistance welding, electronic motor control, high frequency inductive heating of metals, high frequency capacitive heating of dielectric materials and other electronic apparatus for a few miscellaneous applications are dealt with. A lucid account of the principles of operation of the circuitory is given under each application with numerous circuit diagrams and graphs. For several of these applications, complete circuits employing Philips valves with component values are given. Mathematical relationships of electrical quantities involved, are briefly discussed in the appropriate places, in order to give an outline of general design considerations. Data of some preferred types of Philips tubes for industrial application are given at the end.

The get-up of the book leaves nothing to be desired as all the Philips publications are, and the entire matter is printed in beautiful art paper. The book is very informative and would be welcomed by all those, who are interested in the applications of electronic techniques.

X-ray Attenuation Coefficients from 10 kev. to 100 Mev. By Gladys White Grodstein. (National Bureau of Standards Circular 583, issued April 30, 1957.) (Order from Superintendent of Documents, U.S. Government Printing Office, Washington-25, D.C.) Pp. 54. Price 35 cents.

This publication results from widespread requests for basic input data for evaluating the penetration of radiation. Some of the data presented in this NBS Circular has already been published in radiological handbooks and technical journals. The present form is a more extensive and systematic study. It will be useful to physicists studying basic problems in radiation and nuclear physics, to physicians and hospitals utilizing radiation from X-ray generators and gamma rays from radioactive substances, and to designers of shielding for nuclear reactors.

In addition to tabular and graphical data for 29 absorbing materials, which make up the bulk of the publication, there is a discussion of the principal absorption and scattering processes involved in the interaction of radiation with matter: namely, photoelectric effect, scattering (Compton and Rayleigh), and pair production. Existing theoretical and experimental data for these processes have been compiled and evaluated.

Separate tabulations have been made for the probabilities of the dominant interactions as well as the total attenuation coefficient—the sum of the above processes. It appears that the present information is adequate for many applications. However, improved theory and additional experimental data are needed in certain areas. This need is pointed out by a comparison of the calculated and experimental coefficients.

Industrial Electronics Circuits. By R. Kretzmann. Philips Technical Library), 1957. Pp. 199. Price 35 *sh.*

This book is a sequel to *Industrial Electronics Handbook* by the same author and the two together form a continuous whole. A vast number of circuits, employed for industrial controls and in making electronic equipment for varied purposes, are given. The circuits described use Philips tubes and are complete with component values. Brief descriptions as to the nature of the circuits and the manner in which they function make the work, of immense interest.

Circuits appear under six major classifications: (1) photoelectrically controlled apparatus, (2) counting circuits, (3) stabilising circuits, (4) contact and control devices, (5) oscillator and amplifier circuits, (6) rectifier and motor control circuits. These six headings cover well over 90 separate applications, and in the opinion of the reviewer contains a wealth of circuitory that will interest industrial engineers, technicians and all those who are engaged in the building and development of electronic equipment.

The book is beautifully got up and is simple and clear in its presentation. It is certainly a very useful and welcome addition to the one, mentioned at the outset by the same author.

Chromatography: A Review of Principles and Applications. Second completely revised and enlarged edition. By E. Lederer and M. Lederer. (Elsevier Publishing Co.), 1957. Pp. xx + 711. Price 72 *sh.*

The first edition of this book was published in 1953 and was subsequently reprinted in 1954 and 1955. The present second edition was projected on account of the need to bring the matter up-to-date and also to eliminate work which had become obsolete. The result is a major revision as will be clear from the fact that the volume contains 50% more pages, illustrations and Rf tables than the first edition and twice the number of references; the authors have also added an Appendix of references published after the book went to Press.

As a technique for the analysis of mixtures of chemical compounds, chromatography is

unique in its importance. Though Tswett introduced it about the beginning of this century it has developed rapidly during the past three decades beyond all expectations and it is still a rapidly expanding field. It markedly differs from other standard laboratory methods of separation in employing a wide variety of techniques, adsorbents and solvents.

The book begins with a brief history of chromatography and contains five divisions, each division having a number of chapters. The first three divisions deal with adsorption chromatography, ion exchange chromatography and partition chromatography which constitute the three major types. In each division the technique is discussed with reference to the apparatus, materials and special features. Division IV deals with the chromatography of organic substances in the course of 21 chapters constituting more than half the book. This provides a comprehensive account of a large number of groups of organic compounds in relation to their chromatography. The last division (V) concerns the chromatography of inorganic substances. Literature references occupy nearly 100 pages and the index is comprehensive.

This book presents a critical review of the chromatographic methods developed during recent years. It provides information on existing methods in any given field and the literature references help in obtaining necessary details from original papers. The large collection of Rf values is an important feature of the book. Written by authors who are among the pioneers in the use of chromatographic techniques, the book is invaluable to all investigators in the fields of organic and inorganic chemistry for whom the method is of daily use.

T. R. SESHADRI.

Methods of Biochemical Analysis. Vol. IV. Edited by David Glick. (Interscience Publishers, Inc.), 1957. Pp. ix + 362. Price $ 8.50.

The ever-increasing pace of biochemical research has created the need, on the part of the investigator, the teacher and the student alike, to keep abreast of developments in methods and techniques and hence an annual review service is of distinct value for the growth of fundamental research. Necessarily only a few subjects can be included in any single volume and a certain amount of haphazardness cannot, therefore, be avoided. Nevertheless a judicious selection of topics of current importance is made each time. While there has been a generally uniform pattern in the organization of individual chapters, there is also considerable variation in style and presentation which allows for the projection of the author's own expression. The topics have included physical, chemical and biological assay procedures as well as basic techniques and instrumentation for determination of enzymes, vitamins, hormones, carbohydrates, lipids, proteins, minerals, other metabolites and antimetabolites.

The present volume has contributions relating to determinations of carotene, vitamin A, polyunsaturated fatty acids, urinary ketosteroids, amino acids by use of bacterial amino acid decarboxylases, serum acid phosphatases, sulfatases and succinic dehydrogenase activity, and one on the maintenance of constant pH for kinetic studies in biological systems. Each chapter presents a critical evaluation of various approaches and a presentation of the procedural details of the methods recommended by the authors. The close association of the authors with the respective fields renders these reviews particularly useful and authoritative.

A. S.

The Chemistry of Heterocyclic Compounds, Vol. X. (*1, 2, 3- and 1, 2, 4-Triazines, Tetrazines and Pentazines and Their Derivatives.*) By J. G. Erickson, P. F. Wiley and V. P. Wystrach. (Interscience Publishers, Inc.), 1957. Pp. xi + 261. Price $ 10.50.

The chemistry of triazines and tetrazines are so intriguing that few venture into this field, although members of this heterocyclic group offer fertile opportunities for fine structure determination. The appearance of the book under review is sure to help prospective workers to formulate schemes of investigation.

Three triazines are theoretically possible: the 1, 2, 3-, the 1, 2, 4-, and the 1, 3, 5-triazines. The parent compounds are unknown, but derivatives of each have been prepared. The chemistry of the 1, 2, 3- and the 1, 2, 4-triazines has been treated exhaustively by Dr. J. G. Erickson. The 1, 2, 3-triazines condensed with carbocycles have been investigated more intensively and Chapter I affords the reader a thorough review of the chemistry of the system. The almost certain presence of the grouping -N : N-N- makes the system easy of cleavage and hence structural determination creates many difficult points of ambiguity. All these are clearly explained.

The first synthesis of a 1, 2, 4-triazine was reported in 1889 and as far as is known this system seems to have offered no widespread utility. The parent of this class can exist in two non-equivalent Kekule' forms. Two compounds are known in which a 1, 2, 4 ring has one carbon atom in common with a pentane ring

constituting spiro-rings. Cyclic 1, 2-diquinones react to form condensed 1, 2, 4-triazines, the reaction of camphorquinone being illustrative of the same. Many compounds of the 1, 2, 4-benzo-triazine group are known, and those condensed with heterocycles have attracted attention. Chapter II gives a very delightful account of all the known facts about 1, 2, 4-triazines.

The study of 1, 2, 3, 4-tetrazines probably originated from investigations on the oxidation products of osazones of 1, 2-diketones. Chapter III, written in clear style by Dr. V. P Wystrach, is devoted to the synthesis and reactions of 1, 2, 3, 4-tetrazines. As a class they have not been very extensively studied. The general method of synthesis arose from the work of Zincke and Lawson (1886) on the chemistry of certain azo-compounds. No compound containing the 1, 2, 3, 5- or *as*-tetrazine ring has yet been described. The 1, 2, 4, 5- or *s*-tetrazine and its dihydro-, tetrahydro-, and hexahydro-derivatives have received considerable attention. The chemistry of this group has been presented in a delightful manner by Dr. P. F. Wiley. The colour schemes of these compounds present interesting speculation. *s*-Tetrazines are deeply coloured, being deep red, bluish-red, or violet-red. The dihydro derivatives are usually white or yellow solids, the tetrahydro- and hexahydro-*s*-tetrazines are white solids. The pentazines should still be considered as not having been synthesised, the compounds claimed to be pentazines seem to be tetrazole derivatives.

The monographs on the chemistry of heterocyclic compounds have given researchers instructive reading matter. The present volume, the tenth in the series, gives a comprehensive account of a group of compounds which are not usually even mentioned in many text-books. It is a very welcome addition to literature and is sure to give much profit to those who study the volume carefully.

K. N. MENON.

The Physiology of Reproduction in Fungi. By Lilian E. Hawker. (*Cambridge Monographs in Experimental Biology*, No. 6.) (Cambridge University Press, Cambridge), 1957. Pp. 128. Price 15 *sh.*

Dr. Lilian Hawker's *Physiology of Reproduction in Fungi*, which has just appeared as the sixth in the series of the Cambridge Monographs in Experimental Biology, is a worthy addition to that series. It may be read as a follow-up of Professor Ingold's excellent book on "Dispersal in Fungi", published a few years ago.

The book is intended as a survey of the available information on the physiology of reproduction in fungi which is indeed a field of fascinating and useful interest in experimental mycology and one which doubtless deserves more attention from investigators that it has received hitherto. Following an Introduction, the book is divided into six Chapters: (*i*) The growth of spores and of spore-bearing structures; (*ii*) The physiology of vegetative reproduction; (*iii*) The effect of environment on sporulation; (*iv*) The effect of nutrition on sporulation; (*v*) The physiology of sex; and (*vi*) Reproduction in the natural habitat. The book concludes with a useful bibliography giving full citations of all the papers referred to in the text and an index.

As a review of this complex field of experimental research, this book is an achievement for its learned author and a most useful and concise summary for those interested in the physiology of fungi. The entire subject is dealt with most lucidly and written in a simple and precise style with little of what may be termed 'horrid and frightening scientific jargon'. In particular, the Chapters on the effect of environment on sporulation, on the effect of nutrition on sporulation and on the physiology of sex are examples of elegant presentation of information spiced with discrete and stimulating discussion. Hypotheses relating to metabolism and the reproductive phase, and to heterothallism and the physiology of sex in fungi are admirably stated and critically discussed on the basis of available experimental evidence. There is no doubt that the lucid and critical analyses of these fascinating facets of fungal physiology would stimulate thought and further work on these problems, and this in itself should commend the book for careful study.

There are, however, one or two lines on which improvement may be sought in future editions of this valuable book. A greater emphasis on techniques would doubtless be useful for investigators; for instance, mention is made on page 87 of Raper's use of a perfusion technique for demonstration of chemical control of sexual reproduction in fungi. Whilst details of this technique can be gathered from Raper's original paper, brief elucidation of these in the text of the present book would have been useful. Many other similar examples can be cited. Indeed, a chapter on techniques, if included in future editions of this book, would prove most useful for investigators. Another deficiency (if that is a deficiency at all) is the somewhat cursory treatment of the subject under the

Chapter on "Reproduction in the natural habitat". Whilst mention is rightly made of the excellent and painstaking work of Wilkins and his collaborators on the ecology and fruiting of fungi in natural habitats, the notable work of Friedrich and others in this field is omitted. Again, under Chapter 5 on the effect of nutrition on sporulation, the effect of trace elements on sporulation could have been dealt with in greater detail.

Notwithstanding these omissions, Dr. Hawker's book ranks as the first in introducing in detail the physiology of reproduction in fungi to scientific readers. It is a difficult task admirably fulfilled within the small compass of 128 pages and is well worth the price of fifteen shillings and, what is more, worth repeated reading and careful study by mycologists investigating fungal physiology.

C. V. S.

Advances in Enzymology, Vol. 18. Edited by F. F. Nord. (Interscience Publishers, Inc.). 1957. Pp. v + 435. Price $9.00.

Few other volumes on advances in Biochemistry have become so indispensable as those on advances in Enzymology, and it is, therefore, pleasing to note, that in the present volume, which is the eighteenth in this series, Editor Nord has maintained the same high standards of excellence of the earlier volumes, both in the selection as well as in the editing of the review articles. There are nine reviews in all in this volume and most of them have been drawn from the biochemistry of the plant kingdom. The first article on 'Cytochrome in Higher Plants' by E. F. Hartree gives a most up-to-date and readable account of the nature and properties of the cytochrome components, their distribution, detection and estimation as also the interrelationship which exists between cytochrome and photosynthesis. Another article in the same field is the one entitled, 'Reaction Paths in the Respiration of Higher Plants' by W. O. James. The author reviews the various pathways of carbon metabolism in plants including a survey of the enzymes concerned in electron transfer and in phosphate transfer. R. A. Peters, in his article, gives an account of the mechanism of the toxicity of the active constituents of South African cattle poison, *Dichapetalum cymosum*, as well as of related compounds. He has, however, confined himself to a consideration of only the monosubstituted CF compounds such as their general toxicity and the biochemistry of fluoracetate and its mode of action and has made no attempt to deal with CF_2 or CF_3 compounds. Other articles which are of equal interest and importance are: (i) Newer knowledge of succinic dehydrogenase, by T. P. Singer, E. B. Kearney and V. Massey; (ii) Deoxy Ribonucleo-protein, A Genetic Material, by J. A. V. Butler and P. F. Davison; (iii) Pyrophosphorylases and Phosphorylases in Biosynthetic Reactions, by A. Kornberg, (iv) Le-role Biosynthetique du Cycle des Acides Tricarboxyliques, by J. M. Wiame, (v) Chemistry and Function of Lipoic Acid, by L. J. Reed; and (vi) Lignification, by W. J. Schubert and F. F. Nord. However, the newer knowledge about succinic dehydrogenase will have to be necessarily supplemented by the recent advances reported in this field by D. E. Green and others and the same appears to be true in regard to such other articles as deoxyribonucleoprotein and lipoic acid, where significant progress has taken place since the publication of this volume. All the same, the several articles presented here serve a very useful purpose of focussing attention of the biochemist to the very rapidly advancing frontiers of biochemical knowledge and coming as they do from authors who have spent years of study and research in these different fields, they are most enjoyable to read and thought-provoking in the extreme. There are a few misprints in the text such as adenine for adenosine in page 222 and DNA for DNP in page 161; but these are minor blemishes in what is otherwise an excellent volume, elegantly printed with cumulative index for volumes one to eighteen. Undoubtedly, biochemists will find the volume under review, extremely useful to keep abreast of recent advances in enzyme chemistry.

P. S. Sarma.

Books Received

A Second Course of Electricity. By A. E. E. Mckenzie. (Cambridge Univ. Press, London, N.W. 1), 1956. Pp. viii + 357. Price 18 *sh.*

The Effects of the Sulfonylureas and Related Compounds in Experimental and Clinical Diabetes. By Rachmiel Levine and others. (*Annals of N.Y. Acad. Sciences*, Vol. 71, Art. 1, 2, East Sixty-third Street, New York-21), 1957. Pp. 292. Price $4.00.

Advances in Food Research, Vol. VII. Edited by E. M. Mrak and G. F. Stewart. (Academic Press, Inc.), 1957. Pp. x + 404. Price $9.50.

A Practical Guide to Plant Sociology. By F. R. Bharucha, N. C. Deleeuw. (Orient Longmans, Nicol Road, Bombay-1.) Pp. v + 46.

Transactions of the Society of Rheology, Vol. I. Edited by B. Maxwell and R. D. Andrews. (Interscience Pub.), 1957. Pp. 222. Price $6.00.

SCIENCE NOTES AND NEWS

Smut on *Sclerostachya fusca* (Roxb.) A. Camus in Bihar

R. K. Singh and D. N. Mishra, Sugarcane Research Institute, Pusa, Bihar, write that in December 1955, several leaf-spindles of *Sclerostachya fusca* (Roxb.) A. Camus were found swollen. Examination of these galls revealed the presence of innumerable black smut spores covering a whip-like structure. These spores measured 4·3-7·7 microns (average 6·1 microns) in diameter and agreed with the size given by Mundkur for *Ustilago consimilis* Syd., previously reported from Assam. This is the first record of the fungus from Bihar on this host.

Foot-and-Mouth Virus Photographed

H. L. Bachrach and S. S. Breese, Jr., of the Plum Island Animal Disease Laboratory of the U.S. Department of Agriculture, report that they have purified, isolated, and photographed the foot-and-mouth disease virus. Their first electron micrographs of the virus show that it is spherical in shape and about one-millionth of an inch in diameter. This is the smallest of any of the viruses affecting animals—even smaller than poliovirus. These new findings about the physical make up of foot-and-mouth disease virus are expected to speed research on the development of new and effective means of combating the disease, which has great economic importance to livestock production throughout the world.

France Builds a Solar Furnace

The biggest mirror in the world is being built at Mount Louis, near Perpignan, by the Laboratoire de L'Energie Solaire and 3 years hence will be installed in one of the neighbouring valleys that lead down from the Eastern Pyrenees towards Mount Louis.

The main mirror will have an area of about 580 sq. feet. It will be built out of a large number of small mirrors each individually adjusted to parabolic shape. But this mirror—although the largest—will itself be the receptacle of light collected by 60 mirrors each having an area of 385 sq. ft. and mounted to follow the movement of the Sun. The use of a valley site will enable the collecting mirrors to be so placed at different levels along either side of the valley that no one of them will be blocked by the others.

Although there are other experiments at Mount Louis—for example, on the use of solar energy to operate a refrigerating machine—the production of high temperatures is thought to be the more immediately promising.

Sun Photographed from 83,000 ft.

Officials of the U.S. Office of Naval Research Projects announced at Minneapolis that the flight into the stratosphere of an unmanned balloon to take photographs of the Sun had been an outstanding success. During the five hours for which the balloon remained at its pre-determined height of 83,200 ft., 8,000 photographs were taken at one second intervals with 35 mm. film. The gondola containing the camera was automatically released when the operation was completed, and landed by parachute near Scarville, Iowa, several hundred miles from Huron, South Dakota, where the balloon took off. Dr. Martin Schwarzschild, the Princeton astronomer who is the head of the research project office said that the photographs of the edge of the Sun is unprecedented in sharpness. Hot turbulent eddies were visible close to the edge; and magnetic storms could also be detected. It was also said that the picture taken on both occasions indicated that "many of our ideas about the make-up of the Sun have to be reconsidered".

Fluorination of Drinking Water

The World Health Organization has reported that the use of fluorinated drinking water to prevent tooth decay is safe, effective and practical. After a study of hundreds of fluorination programmes in 17 countries, a WHO Committee has announced that the use of fluorine in drinking water-supplies is approved by responsible public health officials throughout the world.

In the United States, 32 million people in more than 1,500 communities are drinking fluorinated water. Sixteen other countries have begun similar programmes.

The WHO Committee Report emphasized that results in all nations using fluorinated drinking water show remarkable uniformity. Dental caries in the permanent teeth of children decreased by about 60%, while in children's primary teeth the reductions ranged from 50 to 60%.

No other public health procedure has had during the initial stages of its application, such

a background of study in terms of both time and expense, the Report said. Without qualification or caution, WHO recommends the use of fluorinated drinking water wherever and whenever possible. It was suggested that treated water contains 1 part of fluorine for every 1 million parts of water.

Production of Synthetic Mica in USA

Large-scale production of synthetic mica by Synthetic Mica Corporation, New Jersey, is reported to be successful. Synthetic Mica Corporation prepare crystals of four inches by one-eighth inch routinely although the yield of such crystals is low.

To produce synthetic mica, a mixture of silica sand, calcined alumina, calcined magnesia, potassium silico-fluoride and an auxiliary source of potassium such as feldspar are used in the proportions desired in the product. Heating is carried out in an electric arc furnace up to 1,300° C. to 1,400° C. which is maintained until 40 to 50% of the material has melted. This mass is then slowly cooled (one degree or less per hour) to room temperature. The rate of cooling is one of the most important factors leading to large crystals.

The type of mica prepared is of the fluorphlogopite type ($K_2Mg_6Al_2Si_6O_{20}F_4$) as its synthesis is easier than that of muscovite. Large crystals (only a few per batch usually) are separated from the mass for use in vacuum spacers, and other applications. The remainder of the melt is crushed, ground, mixed with glass and other ingredients and moulded into final shapes.

Neutron Interactions

More than 150 outstanding nuclear physicists representing the United Kingdom, the U.S.S.R., France, India, Japan, Italy, Sweden, Germany, Norway, Denmark, the Netherlands, and the United States met in September (9th to 13th) at Columbia University to participate in the International Conference on the Neutron Interactions with the Nucleus. I. I. Rabi, Higgins Professor of Physics at Columbia, and Nobel Prize winner, presided over the Conference, and W. B. Lewis, Vice-President of Atomic Energy of Canada, Ltd., served as Vice-President. The many distinguished participants included Homi J. Bhabha of India and Francis Perrin of France.

The Meeting was held under the auspices of the International Union of Pure and Applied Physics. In addition to the host, the Columbia University, the sponsors were the U.S. Atomic Energy Commission, the Office of Naval Research and the Air Force Office of Scientific Research.

Advances in Titanium Technology

Two new developments have recently been reported in the technology of titanium. Armour Research Foundation have announced a cold chlorination process for production of titanium tetrachloride, used as an intermediate in the manufacture of titanium. The current 100-year-old high temperature chlorination process requires rutile as the starting material but the cold chlorination can be applied to such low titanium ores as ilmenite and careful cost estimates indicate that it is financially competitive. The Foundation are now seeking an industrial sponsor for a development programme. Meanwhile Boeing Airplane Co. have stated that progress is being made in forming the titanium sheet metal by working at temperatures above 800° F. While formability was satisfactory, the conventional die lubricants broke down at these temperatures. Satisfactory lubricating properties were found in glass frits which prevent galling between the dies and the parts, and also decrease the oxidation of the parts. Special glass compositions have now been developed. They are made up in organic suspensions and have indefinite shelf life. After the forming operation, they are readily removed in hot 10-30% caustic soda solutions.

New High-Strength Steel

Although many steels can be heat-treated to strengths of 300,000 lb. per inch and higher, they are normally quite brittle at this strength level. Such brittleness prohibits their use in structural applications where a certain amount of ductility and toughness is required.

The National Bureau of Standards has experimentally produced steel that can be heat-treated to a strength of 285,000 lb. per inch with sufficient ductility for structural applications. Developed by Samuel J. Rosenburg and Carolyn R. Irish of the Bureau's thermal metallurgy laboratory, the steel is made by normal melting and working process and should not be difficult to manufacture.

One of the principal applications for such materials is in aircraft landing gears. Because landing gears constitute approximately 10% of the weight of an empty military plane, the use of an ultra-high-strength steel in such components can save considerable dead weight.

Association of Microbiologists of India

Association of Microbiologists of India formed in 1938 and affiliated to the International Congress of Microbiology, decided at a meeting held in Calcutta to widen the scope and activity of the organisation by inviting in its fold workers not merely from such fields as medicine, veterinary and plant pathology, but also from soil science, food preservation, dairy, leather, jute, textile and fermentation industries. The Association will be concerned with both fundamental and applied aspects of the study of bacteria, viruses, microfungi, protozoa and microscopic algæ, its members being united by the common aim of developing scientific knowledge concerning micro-organisms.

The Association has accordingly elected a widely representative Organising Committee and a 22-man Steering Committee with Major-General S. S. Sokhey as President to carry out the programme.

Annual Conference of the Association will be held in the first week of January 1958, during the Forty-Fifth Session of Indian Science Congress in Madras. Prof. M. S. Thacker, President of the Indian Science Congress Session, will be the Guest-in-Chief.

Workers interested in the field of Microbiology are requested to contact the Secretary, Association of Microbiologists of India, Indian Institute for Biochemistry and Experimental Medicine, P. 27, Prinsep Street, Calcutta-13.

Shark Fossil

The Chicago Museum of Natural History has announced discovery of a fossil shark that is 250 million years old. The Museum reports that the fossil was found in shale formations in Parke County, Ind., several weeks ago by Rainer Zangerl and Eugene S. Richardson, Jr.

This is believed to be the first well-preserved shark fossil ever found from the Carboniferous period. The remains of the shark measure 8½ ft. in length, and it is estimated that they would have been about 15 ft. long had they been complete. Because sharks have cartilagenous skeletons, they are rarely preserved as fossils. (*Science*, 1957, 126, 157.)

Rare Element

Members of the staff of the Physical Technical Institute of the Academy of Sciences of the Kazakh Soviet Socialist Republic, with the aid of spectral analysis, have found the rare element rhenium in deep layers of copper ores in the Jezakazgan deposits in Central Kazakhastan.

The discovery is of great interest because it facilitates the production of rhenium for industrial purposes.

This element is a splendid substitute for tungsten and molybdenum in making filaments for electric lamps and electrotechnical instruments. Hitherto rhenium could only be obtained from sulphurous molybdenum.

Birbal Sahni Institute of Palaeobotany, Lucknow

The Tenth Annual Scientific Meeting of the Palæobotanical Society will be held at the Institute's premises on the 21st and 22nd of January 1958. The programme chalked out includes lectures, reading of papers and discussions. Palæobotanists from all over India are expected to participate.

Indian Standards Institution

Indian Standards Institution will hold its Annual Convention at Madras from 22 to 28 December 1957. Some 600 delegates have accepted the Institution's invitation to participate in the discussions and about one hundred technical papers are expected to be presented for discussions by specialists in the fields.

Award of Research Degree

Shri K. Bhaskara Rao has been awarded the D.Sc. Degree in Chemistry of the Andhra University, for his thesis entitled, "Catalysed Reactions in Volumetric Analysis".

Miss V. R. Meenakshi has been awarded the Ph.D. Degree in Zoology of the Annamalai University, for her thesis on "Physiological Studies of *Pila virens* with Special Reference to Aestivation".

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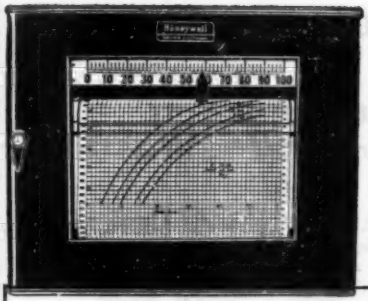

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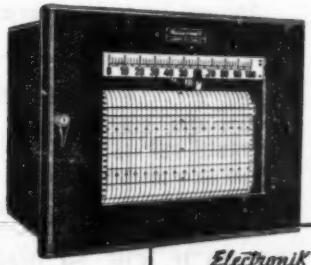

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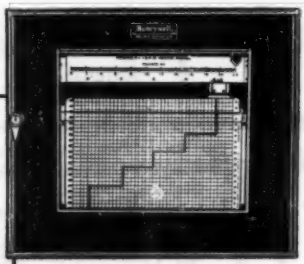

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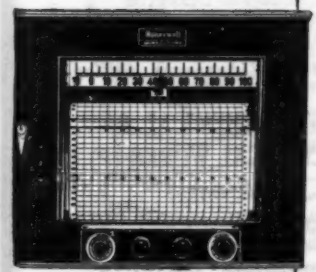

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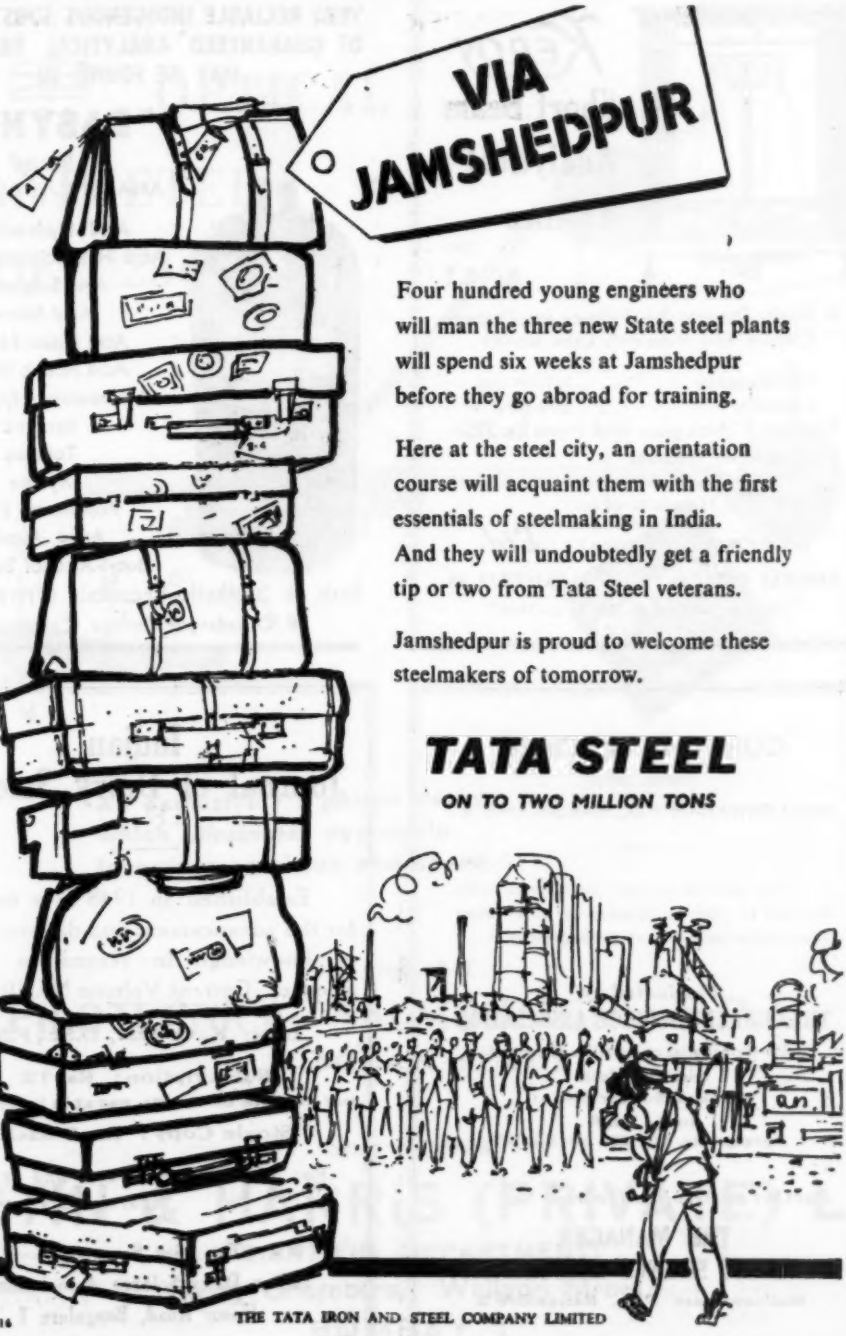

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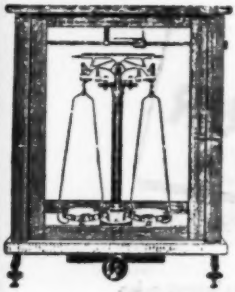

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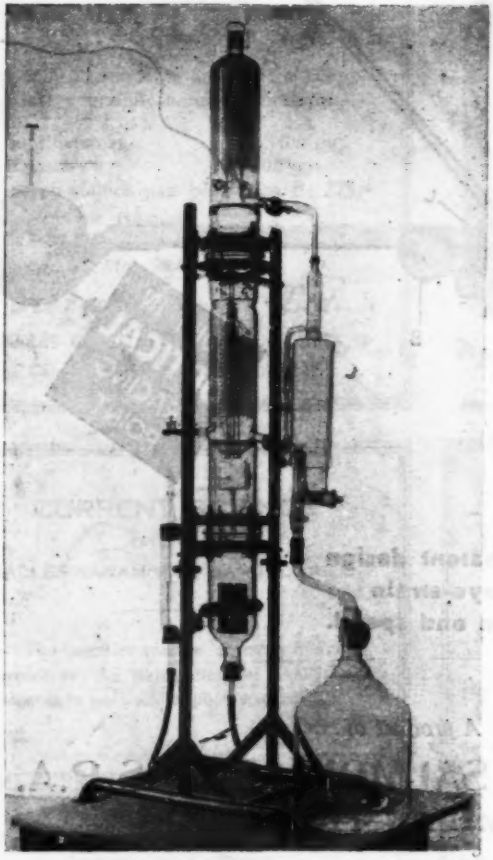

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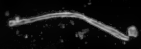
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